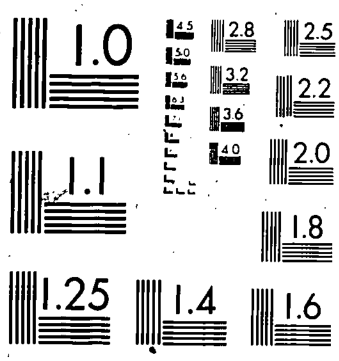

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ABSTRACT

The question of whether the United States' measurement system should be changed is still unresolved. This General Accounting Office (GAO) report provides information on metrication and the issues involved. The results of GAO's work is summarized in an Executive Summary. The report contains recommendations to the United States Metric Board and the Office of Management and Budget to help implement current national policy in accordance with the 1975 Act and its legislative history. The report also contains a number of recommendations regarding other specific measurement activities. (MP)

BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

Getting A Better Understanding Of The Metric System--Implications If Adopted By The United States

Whether the Nation's measurement system should be changed is a question still unresolved. GAO has looked into the subject of metrication--conversion to the metric system of measurement. This report provides the Congress, the Administration, the newly formed U.S. Metric Board, and in turn all Americans with a better understanding of the issues involved.

UNITED STATES GENERAL ACCOUNTING OFFICE

CED-78-128
OCTOBER 20, 1978

COMPTROLLER GENERAL OF THE UNITED STATES
WASHINGTON, D.C. 20548

B-140339

To the President of the Senate and the
Speaker of the House of Representatives

This report discloses the implications if the United States converts to the metric system of weights and measures. Also, it discusses the conversion experiences of other countries.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53).

We are sending copies of this report to the Chairman of the U.S. Metric Board; Director, Office of Management and Budget; the Secretaries of Commerce, Transportation, Treasury, and Health, Education, and Welfare; other Federal and State government officials; and officials of associations and private companies.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

GETTING A BETTER UNDERSTANDING OF THE METRIC SYSTEM--IMPLICATIONS IF ADOPTED BY THE UNITED STATES

DIGEST

THERE IS A LOT INVOLVED IN A CHANGE

With the exception of the United States and a few small countries, the rest of the world has adopted or is in the process of adopting the metric system. So why shouldn't we, as a Nation, join the rest of the world in adopting this logical measurement system? Sounds reasonable? But is it? Let's take a look at what is involved.

Metrication is much more than simply learning and using the metric system; related ramifications include

--determining the best time to convert in order to minimize costs;

--agreeing on metric sizes;

--designing, producing, and building in metric dimensions;

--training personnel in metric;

--obtaining metric supplies;

--changing laws, regulations, ordinances, and codes to accommodate the metric system;

--informing customers about metric products; and

--remaining competitive in the marketplace.

Converting to the metric system would mean thinking, hearing, and seeing things in metrics--such as distances in terms of meters, volume in terms of liters, weight in terms of grams, and temperatures in Celsius. It would mean new sizes for screws and bolts; new distances on maps; new weights on scales; new speed limits on highways; new tools to

repair automobiles and other products; new sizes for beverages, food, and clothing; new recipes in the kitchen; and revised educational materials. Of course, it does not mean that all sizes, distances, and weights actually would change (although a great many would); but the terminology and numbers used to express them would. The change would not necessarily be sudden and complete.

Metrication would affect Americans at work, in school, at home, in shopping, and in their leisure activities. Every organization, firm, industry, and level of government would feel its impact. The impact would surprise many Americans and affect them all in many and varied ways. No country with an economy and population anywhere near the size of the United States has converted to the metric system.

A DECISION HAS NOT BEEN MADE

Many believe a decision has already been made to adopt the metric system in the United States. In fact many think conversion is mandatory, especially small businesses and the general public. Responses to GAO's questionnaires showed that 42 percent of the small businesses and 30 percent of the building and construction associations, and 23 percent of the people contacted in a public opinion poll conducted for GAO, believed conversion to the metric system is mandatory. Less than 20 percent knew what the national policy is. The passage of the Metric Conversion Act of 1975, with its provision of establishing a U.S. Metric Board, is cited by many as being an official national commitment. Just the name of the act connotes conversion. Despite opinions and statements to the contrary, it is not the current United States policy to convert from the present customary system to the metric system.

The 1975 Act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected.

The Metric Board's responsibility under the act is to devise and carry out a broad program

of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert. At the time this report went to print, the Board had not become fully operational.

THE INEVITABILITY SYNDROME

There is insufficient evidence to support or refute the belief by some that conversion to the metric system by the United States is inevitable.

A majority of the large and small businesses and building and construction associations responding to GAO's questionnaires believe conversion to the metric system is inevitable for their industries. Also, a majority of State governments believe metrication is inevitable for themselves.

These beliefs, as much as any perceived benefit, have been a principal impetus for conversion activity in the United States. However, as more people believe in inevitability and convert because of this belief, conversion to the metric system accelerates.

Several factors and beliefs have contributed to this inevitability syndrome including:

--Passage of the Metric Conversion Act of 1975 and its major provision for a U.S. Metric Board. The name of the act connotes conversion.

--Actions taken by some Federal agencies, such as the Federal Highway Administration which attempted to require conversion of highway signs, the National Weather Service's plan to use the metric system for weather reporting, and the suggestion by the Department of Agriculture to convert meat and poultry labels.

--The decision to convert by some of the "giants" of industry and the effect on customers and suppliers.

--The 1971 National Bureau of Standards report which stated that there was no question that the United States should convert within a 10-year period.

--Proposed legislation in the early 1970s which called for a predominantly metric America within 10 years.

--Publicity about metric projects and activities and the distribution of metric information and charts.

--The increase in metric instruction in school programs throughout the country with many setting target dates--1980 for 13 States--when their school systems are to be teaching the metric system as the predominant system.

VOLUNTARY CONVERSION

The United States has a policy of allowing for voluntary conversion--a choice of converting or not converting. This has been the policy since 1866 when the metric system was authorized. During the intervening years, use of the metric system has increased somewhat.

The Metric Conversion Act of 1975 provides for a continuation of the existing voluntary policy, but the current policy has been misinterpreted, and within this context, attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sectors, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

SUPPORT/OPPOSITION AND OVERALL ADVANTAGES/DISADVANTAGES

Responses to the questionnaires sent out by GAO showed that the strongest support for converting to the metric system came from State education officials, State government officials, and the Fortune 500 industrial companies. Building and construction associations supported conversion but not as widely as the above groups. Small businesses were divided in their opinion but more were opposed to metrication than supported it. The public opinion poll conducted for GAO showed most people in opposition to metrication.

The respondents' support for conversion is not based entirely on the belief that they will gain some advantage from converting. In all cases more supported conversion than saw advantages for themselves. Large businesses were divided on whether advantages outweigh disadvantages for their firms. Small businesses believe the disadvantages outweighed the advantages for their firms.

However, when asked about the advantages and disadvantages for the United States overall, both groups shifted to a more positive opinion on advantages.

Thus the question arises as to just who benefits to make it worthwhile for the United States to convert to the metric system.

BENEFITS ARE QUESTIONABLE

Most of the ascribed benefits are goals, such as standardization and rationalization, which have always existed and have been achieved to varying degrees under the customary system. Metrication is being viewed by proponents as the opportunity to achieve these goals (to a greater degree). In order to achieve

Tear Sheet

improvements or benefits sought, the conversion must be a hard conversion--a change in product dimensions, rather than a soft conversion, using metric equivalents. However, actually achieving the benefits is questionable, and their value is generally undeterminable.

The often ascribed benefit that the metric system is easier to use and results in fewer errors is generally but not universally accepted.

Some view metrication as an opportunity to improve production efficiencies, facilitate technological advances, and make other worthwhile changes. Respondents to GAO's business questionnaires generally disagreed with such views. While metrication might provide the opportunity or vehicle for such changes, there is no assurance of achieving them.

Present sizes have developed over the years in the marketplace to meet demand. For some products, industry officials believe that most of these sizes meet their needs. Substantial standardization and rationalization have been achieved under the present customary system and is a continuing goal.

There is little doubt that increased standardization and rationalization could result in benefits, although this objective could be achieved using the customary system. Proponents view metrication as an opportunity or vehicle to achieve the results, but the cost involved is unknown. Metrication would result in dual inventories of customary and metric sizes for a considerable number of years. This would be a very critical problem for many industries, suppliers, and retailers and would cost an undeterminable amount. Only after the period of dual inventories has elapsed would it be known whether increased standardization and rationalization had resulted and at what costs.

Some persons claim that consumers will benefit because price comparisons will be easier to make with the metric system. The premise depends on the willingness and ability of producers to change to rational series of sizes. However, it is quite likely that changes to government laws and regulations would be needed.

It may be that the increased use of unit pricing would be of greater benefit to consumers than converting many sizes to metric. Unit pricing would facilitate price comparisons, be easier to understand, is not dependent on the use of standard or rational sizes which can be difficult and costly to achieve, and would permit producers to make their products in sizes relating to their needs.

For most consumer products and for activities, such as sports (except those involved in international records), no major benefits would occur to either producers, consumers, or participants and spectators by converting to the metric system. Many consumer products are not exported to other countries; producers of those that are seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to U.S. sizes when necessary.

COST WILL BE INCURRED

The total cost of metrication is undeterminable in spite of various estimates that have been cited in the last decade by various organizations and individuals. These estimates vary widely and often are not based on detailed analyses of the factors involved. They generally are low or high depending on the conversion experience of those providing these figures and their position on converting or not converting to the metric system.

Some of the major cost areas include training and educating people; converting computer systems, data bases, and standards; changing laws, regulations, ordinances, and codes; maintaining dual inventories; purchasing hand tools; changing product sizes; and familiarizing consumers with metric terms.

However, based on the limited cost data that was available to GAO and the input from various representatives from a wide spectrum of organizations throughout the country, the cost will be significant--in the billions

of dollars. But whatever the cost, it appears it will be passed on to consumers.

BEVERAGE CASE STUDY

The beverage industry provides a unique early opportunity to look at metric conversions in the United States, particularly with respect to the effect on consumers. Some segments are totally converting, some partially and the remainder are inactive or simply placing metric equivalents on their product labels. Some conversions made by the beverage industry may have benefited consumers and the industry. But other conversions and related actions have been harmful to consumer interests.

The wine and distilled spirits industries are totally converting their products to metric sizes for marketing reasons. The conversion period for wines will be complete by January 1, 1979, and for distilled spirits by January 1, 1980.

Following the favorable sales experiences by one soft drink producer, several other major producers have introduced metric sizes in many areas of the country, usually when new containers are introduced. The soft drink industry had not planned an overall metric conversion in the near future.

The beer industry sells all its products in customary sizes and did not plan to convert to metric sizes. Some brewers, however, show metric equivalents on their labels. The industry sees no conversion benefits, only costs.

Most milk containers show metric equivalents, but all milk is still sold in rational customary sizes. The industry has no plans to convert to metric sizes and sees no benefits in doing so.

While further adoption of rational package sizes is a laudable objective for beverages, it is one that could be achieved without converting to the metric system, as with milk.

Metric proponents have stated that consumers will benefit if rational metric sizes are

adopted which would make price comparisons easier. However, GAO's study of the beverage industry showed that this would not necessarily be.

Most wines and distilled spirits that were converted to metric sizes experienced unit price increases of up to 11 percent greater than those that did not convert. It was in the metric sizes that price comparisons are the most difficult to make that the highest price increases took place.

While the impact of the wine and distilled spirits conversions on consumer prices has been largely detrimental so far, it remains to be seen whether the practice of increasing prices of converted products continues through the rest of the conversion periods. It must also be kept in mind that GAO conducted its price study in locations where there is some price control.

On the other hand, the soft drink industry has begun marketing some of its products in rational metric sizes. If this trend continues and a complete conversion is made to metric sizes, price comparisons should be easier for consumers. It has been stated, at least in some instances, that prices were not increased when conversion occurred. However, GAO was unable to independently verify the actual pricing of soft drinks.

EFFECT ON TRADE IS UNCERTAIN

Because most countries use or are converting to the metric system, the United States cannot deny the existence of the system or prohibit its use. However, a multitude of factors affect world trade; and the business respondents to GAO's questionnaires and exporters and importers contacted by the National Bureau of Standards in its study considered the measurement system used to be of minor importance.

A majority (60 percent) of the largest U.S. industrial businesses--the Fortune 500--who responded to GAO's questionnaire believed conversion would facilitate trade through a common

measurement language, but over 80 percent indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms responding cited factors, such as competitive prices, high quality, superior technology, and good reputation and reliability, as being of major significance in promoting exports. Engineering standards and the design and manufacture of products in either metric or customary units were considered to be of major significance in promoting trade by relatively few of the respondents. Less than 5 percent of the respondents considered measurement units to be of major significance in deterring trade.

American firms have been trading for centuries with countries that (1) use various measurement systems, (2) have different requirements and laws that must be complied with, and (3) speak different languages. Information was not available on the extent that other countries have adopted and use the entire international metric system. GAO found no evidence to show that the Nation's trade would be significantly affected by converting to the metric system or remaining with the customary system.

THE DECISION TO BE MADE

A matter to be considered is whether the use of the metric system throughout the world warrants the effort and expense needed to convert our day-to-day affairs, such as highway speed limits, consumer products, and weather reporting, into metric measures.

There is no question that one system should be predominant because the existence of a dual system for any length of time is impractical, inefficient, uneconomical, and confusing. It is not too late to make the decision as to which system is to be predominant. The decision is not an easy one because valid national conversion costs and the value of any benefits are not available.

Since a decision will affect every American for decades to come, GAO believes the decision, which is to continue with the current policy

or change it, should be made by the representatives of the people--the Congress.

GAO believes that this report will provide valuable information on metrication and the issues involved to the Congress, the Administration, the newly formed U.S. Metric Board, and to the American people. The results of GAO's work is contained in a detailed report (CED-78-128) and is summarized in an Executive Summary (CED-78-128a).

AGENCY COMMENTS AND GAO'S EVALUATIONS

In commenting on GAO's report, the U.S. Metric Board's Ad Hoc Committee stated that the report contained detailed information on the status of voluntary conversion in many sectors of the economy which will be used by the Board. However, the Board disagreed with some aspects of the report which are discussed in detail in the Executive Summary and in chapter 31 of the basic report.

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The report contains recommendations to the U.S. Metric Board and the Office of Management and Budget to help implement the current national policy in accordance with the 1975 Act and its legislative history. The report also contains a number of recommendations regarding other specific measurement activities.

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ABBREVIATIONS

AFL-CIO	American Federation of Labor and Congress of Industrial Organizations.
ANMC	American National Metric Council
ANSI	American National Standards Institute
FAA	Federal Aviation Administration
GM	General Motors Corporation
ICAO	International Civil Aviation Organization
ISO	International Organization for Standardization
NATO	North Atlantic Treaty Organization
NBS	National Bureau of Standards
SI	International System of Units

CHAPTER 1

INTRODUCTION

CHAPTER 1

INTRODUCTION

Meter, liter, and gram. These terms are appearing more and more in the United States, sometimes alone but often with their "cousins," the foot, quart, and ounce. The latter terms are the most familiar to Americans and are part of what is commonly referred to as the customary system of weights and measures. Meter, liter, and gram are part of the metric system. When you hear or see temperature in degrees Celsius, it is also part of the metric system. Use of the metric system is increasing, but the customary system is by far the most predominant in the United States.

A movement is underway, however, to change our system of weights and measures to the metric system. This change, which is voluntary by law in the United States, is often referred to as metrication. There are two types of conversion, hard and soft. Soft conversion means replacing customary measurement units with equivalent metric units without any changes in the size of products, materials, or structures. One quart, for instance, becomes 0.95 liter. Hard conversion means a change in the actual dimensions of the product, material, or structure to metric dimensions--1 quart becomes 1 liter which is 1.06 quarts. Generally, hard conversion results in rounded metric numbers which are easier to work with. (The metric system is explained in detail in ch. 2.)

METRICATION--WHAT IT WOULD MEAN

Many Americans have had some contact with the metric system. Many have worked in or toured metric countries, particularly in Europe, and others were born in and lived a good part of their lives in metric countries before coming to the United States.

In this country, the scientific community, for the most part, uses the metric system. Foreign-made automobiles are metric, and individuals and mechanics who work on them have metric tools. Metric units are appearing on food products and other items next to customary measurements. Skis are measured in centimeters, and 35-millimeter film is common. For several years, students in such courses as chemistry have worked with the metric system. Today many public schools are teaching the system to their pupils. Weather reports are often heard in both Fahrenheit and Celsius (formerly known as centigrade). Nonetheless, use of the metric system is small in comparison to that of the customary system.

Converting to the metric system would eventually mean thinking, hearing, and seeing distances in terms of meters, volume in terms of liters, weight in terms of grams, and temperatures in Celsius. It would mean new sizes for screws and bolts, new distances on maps, new weights on scales, new speed limits on highways, and new tools to repair automobiles and other products. It would also mean new sizes for beverages, food, and clothing; new recipes in the kitchen; and revisions in educational materials. Of course, it does not mean that all sizes, distances, and weights would actually change, but the terminology and numbers used to express them would. Metrication would probably be a combination of soft and hard conversion. The change would not necessarily be sudden and complete.

A change to the metric system would be significant. Metrication would affect Americans at work, in school, at home, in shopping, and in their leisure activities. Every organization, firm, industry, and level of government would feel its impact. The impact could surprise many Americans.

We have looked into the subject of metrication to determine the status and trends in the use of the metric system; its implications for government, industry, and the American people as citizens and consumers; and lessons that can be learned from the experiences of countries that are converting or have recently converted. The Congress, the Administration, and, in turn, all Americans should be fully aware of the ramifications of metrication.

EVOLUTION OF THE METRIC SYSTEM

In 1790 the French National Assembly asked the Paris Academy of Sciences to develop a new system of weights and measures for France. Great Britain was asked to join in this effort but declined in favor of improving its own system. A new system was desired for France primarily because the large number of units that had come into everyday use was confusing. Often, several names were given to the same unit, and units varied from province to province and from city to city. Some French units differed in value from the English units.

After considering several proposals, the Academy decided that the new system should be based entirely on one unit of length. Furthermore, the system would be decimal--based on 10--by adding prefixes such as milli (1/1,000), centi (1/100), deci (1/10), deka (10), hecto (100), and kilo (1,000) to the units to form the larger and smaller versions of each unit.

The unit for length was to equal one ten-millionth of the length of a quadrant of the Earth's meridian; that is,

one ten-millionth of an arc representing the distance between the Equator and the North Pole. The standard for the unit was determined by measuring an arc of meridian between Dunkirk, France, and Barcelona, Spain. The unit was later named the metre (meter). 1/

The unit of mass (weight), called the gram, was defined as the mass of 1 cubic centimeter (a cube that is 1/100 of a meter on each side) of water at its temperature of maximum density. The cubic decimeter (a cube 1/10 of a meter on each side), which was named the liter, 1/ was to be the unit of fluid capacity or volume. The unit of area was to be the square meter. Because of its foundation on the meter, the system became known as the Systeme Metrique (metric system).

After its acceptance by the French Government and a long, stormy period before taking hold in France, the use of the metric system slowly but steadily spread from one country to another. By 1880, 17 nations had officially accepted the system. An additional 18 countries had followed suit by 1900. Today, all countries, except the United States and several small countries, are using the metric system or are committed to its use as their predominant measurement system.

IN THE UNITED STATES, A CONTINUOUS FLIRTATION WITH THE METRIC SYSTEM

U.S. conversion to the metric system has been an issue almost since the creation of the Nation. Numerous bills to require conversion have been introduced in the Congress over the decades, but none passed. Metrication is still an issue.

The Jefferson Plan

The Nation's founding fathers recognized in the U.S. Constitution the importance of uniform weights and measures by giving the Congress the power to fix the standards of weights and measures (art. 1, sec. 8). Thomas Jefferson was requested in 1790 to develop a plan to establish uniformity in currency, weights, and measures for consideration by the House of Representatives. In his report, Jefferson noted the need for an invariable standard of length. He proposed two alternative plans. One was to retain the customary system of

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1/Some controversy exists in the United States as to whether these two units should be spelled with an "er" or "re" ending (see ch. 2). In this report, we have used the er spelling in accordance with the U.S. Government Printing Office Style Manual.

weights and measures but standardize it on the basis of a new standard of length. The second proposal was a new system based on the same proposed standard. Jefferson believed the new system should be decimal. He was aware that the metric system being proposed in France had the basic characteristics he desired in the new system; however, he rejected it because the basic measurement standard could not be reproduced in any country except France.

The weights and measures plan was debated in the Congress for several years but no action was taken. In 1795 and 1796, the Congress also considered but rejected a suggestion from the French Government that the United States adopt the metric system. A plan for a decimal money system based on the dollar, which Jefferson helped develop, was later accepted by the Congress.

The Adams Report

As required by a U.S. Senate resolution, Secretary of State John Quincy Adams in 1821 submitted his "Report Upon Weights and Measures" to the Congress. Adams concentrated his effort on international developments, existing weights and measures regulations in the States, and the available means for obtaining uniformity of the regulations. An important part of Adams' report was a comparison of the English and metric systems and the advantages and disadvantages of each for the United States. Adams concluded in his report that the Congress should not change the existing system but should fix the standards for the units. His survey of the existing situation in each of the 22 States found that substantial uniformity already existed. He believed that the time had not yet arrived in which he could recommend

> "* * * so great and hazardous an experiment * * *, as that of discarding all our established weights and measures, to adopt and legalize those of France in their stead."

Adams was also concerned that the Constitution may not have given the Congress the power to change the whole system of weights and measures when it said to fix the standards.

Use of the metric system is made legal

In 1866 legislation was enacted that made it legal to use the metric system for the transaction of any and all business in the United States. In the proceedings leading to the act, the House Committee on Coinage, Weights, and Measures surveyed the status of the metric system in other nations. The committee's report recommended that the metric

system be legalized to give Americans the opportunity to use it. The committee believed that the country would soon become familiar with its convenience. The report further stated that:

> "* * * When this is attained - a period, it is hoped, not distant - a futher Act of Congress can fix the date for its exclusive adoption as a legal system."

On July 27, 1866, when the bill was passed, the Senate also passed a resolution to distribute metric standards to the States. The President signed the bill the next day. A major factor in the decision by the Congress to pass this legislation was an earlier decision in 1864 by the United Kingdom to make use of the metric system permissable.

Although some in the Congress assumed that use of the metric system would spread in the United States and become the dominant system, it did not. The 1866 act was neither mandatory nor promoted the system's use. No target date for its adoption was established. The metric debate continued.

The United States signs the Treaty of the Meter

The United States, on May 20, 1875, was 1 of 17 nations that signed the Treaty of the Meter--45 nations have now signed it. The agreement provided for a permanent International Bureau of Weights and Measures under the control of a committee of 14 members from different countries. Both of these are under the auspices of the General Conference on Weights and Measures which consists of delegates from all the countries that have signed the treaty.

The International Bureau's primary mission was to construct and verify the accuracy of new, more precisely defined measurement standards for the meter and kilogram. Metal bars representing the length of a meter and metal cylinders representing the weight of a kilogram were constructed and distributed to the member countries to serve as their national measurement standards. The Bureau was responsible for maintaining the meter bar and kilogram cylinder which were to be the international standards. To ensure the continued accuracy and uniformity of measurement standards, the Bureau was to periodically check the international standards against the standards of the member countries and compare them with the different standards of nonmember nations.

The International Bureau and the General Conference on Weights and Measures are still in existence. They serve as

the mechanism for recommending and considering refinements and other changes in the metric system on an international basis.

In 1890 the United States received and accepted its two meter bars and kilogram cylinders. Three years later these were declared to be the Nation's fundamental standards of length and mass (weight) by an administrative action of the Superintendent of Weights and Measures and sanctioned by the Secretary of the Treasury. The meter and kilogram became the fundamental standards for defining the yard and the pound. The administrative action is commonly referred to as the Mendenhall Order.

1960--metric becomes an international system

Over the following years, several bills were introduced in the Congress to convert the United States to the metric system, but they were unsuccessful. However, the United States, as a member of the General Conference on Weights and Measures, had been involved in redefining the metric system and its units in an effort to correct some inconsistencies that had developed.

When the metric system had begun, the most pressing need was to standardize units of measure used in the exchange of goods and services. Later, world growth of science and technology led to the requirement for additional measurement units other than the meter and the kilogram for length and weight, respectively. The new units were sometimes established by different scientific methods, and this often resulted in more than one metric unit for measuring the same physical quantity. Thus, in effect several metric systems were used around the world.

The General Conference decided that an international system was needed to standardize the metric system on a world-wide basis. To meet this need, the General Conference, in 1960, adopted an extensive revision and simplification of the system. This new metric system was formally given the name "Systeme International d'Unites" (International System of Units). Thus, a modernized international measurement system became available for use by all countries. However, many nations have been slow to adopt the new metric system in its entirety.

The General Conference also decided to abandon the meter bar, which had served as the international standard of length,

and substitute a wave length of light. 1/ This was a return to use of a measurement standard found in nature, and it could be produced with great accuracy by a well-equipped laboratory.

The U.S. metric study

After 10 years of similar bills being considered in the Congress, the Metric Study Act (Public Law 90-472) became law in August 1968. The act directed the Secretary of Commerce to

--determine the impact on the United States of the increasing use of the metric system;

--consider the desirability and practicability of increasing its use in the United States;

--study the feasibility of retaining and promoting engineering standards on the basis of the customary system;

--examine the effects on international trade, foreign relations, national security, and also the practical difficulties of greater use of the metric system; and

--evaluate the costs and benefits of alternative courses of action that the United States might take.

The Secretary of Commerce delegated responsibility for conducting the study to the National Bureau of Standards (NBS). NBS generally used questionnaires and hearings supplemented by individual investigations of the manufacturing industry and nonmanufacturing business; consumers; the Department of Defense; Federal civilian agencies; and the areas of education, international trade, engineering standards, international standards, commercial weights and measures, and the history of the metric system controversy in the United States. The results of each area were published in separate volumes. The public hearings were summarized and analyzed in another volume.

As the metric study progressed, the study group concluded that the United States is already increasing its use of the metric system and that sooner or later the United States will probably become predominantly metric. Thus, the study's

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1/The length of a meter was redefined as 1,650,763.73 wave lengths of the orange-red line produced by krypton 86.

major thrust changed from whether the United States should convert to the metric system to how--planned or unplanned.

In July 1971 the Secretary of Commerce issued his report, "A METRIC AMERICA, A Decision Whose Time Has Come." The report stated that eventually the United States will join the rest of the world in using the metric system as the predominant common language of measurement. The basis for this conclusion was that the United States is already metric in some respects, that it is becoming more so, and that the great majority of businessmen, educators, and other informed participants in the study reported that the increased use of the metric system is in the best interest of the Nation. The specific recommendations in the report were:

--The United States should change to the international metric system deliberately and carefully through a coordinated national program.

--The Congress should establish a central coordinating body to guide the change.

--Detailed conversion plans and timetables should be worked out by the sectors themselves within this framework.

--Early priority should be given to educating schoolchildren and the public at large to think in metric terms.

--Immediate steps should be taken by the Congress to foster U.S. participation in international standards activities.

--Any conversion costs should "lie where they fall."

--The Congress should establish a 10-year time frame for the United States to become predominantly metric.

--There should be a firm government commitment to convert.

The report's recommendations did not settle the metric question. Bills to implement the recommendations were debated in the Congress for the next several years; none were passed. Although the advantages and disadvantages of metric conversion for the United States were still an issue, a major area of controversy was the impartiality and completeness of the NBS metric study. The critics, which included former members of the study group and its advisory panel, contended that NBS was biased in favor of conversion while performing the

study and reporting the results. The critics did not believe that the study adequately addressed the costs and benefits of converting.

Metric conversion legislation was passed in the Senate in 1972 providing for a predominantly metric America within a 10-year period. It was introduced in the House where no action was taken. In the following years, various unsuccessful legislative proposals were discussed. Further progress was not made until 1975 when the provision for a predominantly metric America within 10 years was dropped.

In the meantime, the Education Amendments Act of 1974 was enacted. It included a section authorizing $10 million a year for a 3-year period to encourage education agencies and institutions to prepare students to use the metric system. In each of fiscal years 1976, 1977, and 1978, $2.1 million was appropriated for this purpose.

THE METRIC CONVERSION ACT OF 1975

On December 23, 1975, the Metric Conversion Act was enacted. It declared that the policy of the United States is to coordinate and plan the increasing use of the metric system and provided for the establishment of a United States Metric Board to coordinate voluntary conversion to the metric system. The act neither provided a firm commitment to convert nor any time frame to go by and left unsettled the question of who should bear the conversion costs. No financial assistance was provided for under the act.

The act did not stipulate whether the customary or metric system should be the predominant measurement system for use in the United States. The national policy, therefore, is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected.

The Metric Board

More specifically, the act provided that the Metric Board be comprised of 17 members appointed by the President with the advice and consent of the Senate. The members, with the exception of the chairman, are to represent the following sectors of U.S. society: engineering, scientific and technical, manufacturing, commercial and retailing, labor, State and local government, small business, construction, education, and standards-making. In addition, four at-large members are to represent consumers and other interests considered suitable by the President. Labor and small business are to be represented by two members. The other sectors are to each have one

representative. The members are to serve staggered terms of from 2 to 6 years. All may be appointed to an additional 6-year term.

The Metric Board is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. It has no compulsory powers to require any sector of the economy to convert. In this regard, the Board is not to advocate metrication but is to assist various sectors when and if they choose to convert. The act, however, provided that the Congress could give the Board such powers at a later date.

In carrying out the program, the Board is to

--consult with and take into account the interests, views, and conversion costs of commerce and industry, including small business, consumers, labor, government agencies at all levels, metric conversion groups, and such other individuals or groups as are considered appropriate;

--provide for appropriate procedures to obtain the views of affected groups;

--publicize proposed conversion programs, and provide an opportunity for interested groups or individuals to submit comments;

--encourage activities of standardization organizations to develop or revise engineering standards on a metric measurement basis and to take advantage of opportunities to promote rationalization, improvements of design, reduction of size variations, and other opportunities;

--encourage the retention in metric language of those U.S. standards which are internationally accepted or of superior technology;

--consult and cooperate with foreign governments and international organizations to gain international recognition for metric standards proposed by the United States and, during U.S. conversion, to encourage retention of equivalent customary units (usually by way of dual dimensions) in international standards or recommendations;

--assist the public, through information and education programs, to become familiar with the meaning and applicability of metric terms and measures;

--collect, analyze, and publish information about the extent of usage of metric measurements; evaluate the costs and benefits of metric usage; and make efforts to minimize any adverse effects resulting from increasing metric usage; and

--conduct research and surveys, publish the results, and recommend to the Congress and the President appropriate actions to deal with any unresolved problems, issues, and questions associated with metric conversion or usage.

The act mentioned several areas that the Metric Board may study, but to which it was not limited. These are the (1) impact on workers, such as cost of tools and training, and on different occupations and industries, (2) possible increased costs to consumers, (3) impact on society and the economy, (4) effects on small business, (5) impact on the U.S. international trade position, (6) appropriateness and methods for using procurement by the Federal Government as a means to implement conversion, (7) proper conversion or transition period in particular sectors of society, and (8) consequences for national defense.

The Board is required to submit annual reports to the Congress and the President on its activities and the status and projections for the conversion process. These reports may include recommendations for legislation or executive action needed to implement conversion programs accepted by the Board. Not later than 1 year after the Congress appropriates money for the Board, the Board is to submit a report on the need to provide an effective mechanism for converting customary units to metric units in laws and regulations on a coordinated and timely basis in response to voluntary conversion programs adopted and implemented by various sectors of the economy.

The Metric Board is to be independent of any department or agency. It can establish an executive committee and other operational committees it considers desirable, has contract authority, and is authorized to conduct hearings as appropriate. The Board is to operate through an executive director and necessary staff personnel.

The 17 members of the Metric Board were nominated by the President and confirmed by the Senate during the first half of 1978. Although the Board has met several times, it had

not become fully operational at the time this report went to print. In the Senate Committee report on the 1975 Act, it was estimated that the Board would need $2 million for the first year and $3 million per year thereafter. The Board requested $1.8 million for its first full year of operation.

METRIC ORGANIZATIONS

There are two major metric organizations: the American National Metric Council (ANMC) and the U.S. Metric Association. AMMC, a nonprofit organization, was established in 1973 by private sector initiative under the auspices of the American National Standards Institute (ANSI) to assist all segments of the U.S. economy in planning, coordinating, and implementing the voluntary change to the metric system. On July 1, 1976, ANMC became an independently incorporated organization. It is located in Washington, D.C.

The core of the ANMC is its sector committees which coordinate the metric activities in their respective segments of the economy. The sector committees are made up of representatives of industry, government, labor, education, and other groups as deemed appropriate. The more than 30 sector committees are grouped under 5 coordinating committees: materials, engineering industries, construction industries, consumer products, and education and industrial training.

ANMC expects to play a key role in providing input and assistance to the U.S. Metric Board when it becomes active. It does not foresee being absorbed by the Metric Board but continuing to serve as the focal point for conversion activities in the private sector, possibly with some funding from the Metric Board.

The U.S. Metric Association, founded in 1916, is a nonprofit organization. Its main goal has been advocating and promoting the use of the metric system as the primary measurement system in the United States. This has been carried out primarily by means of publications, meetings, and the individual activities of its members. Its membership through the years has consisted mainly of scientists, engineers, and educators. The Association is located in Boulder, Colorado.

SCOPE OF STUDY

We discussed metrication with numerous officials of trade associations, individual companies, Federal and State governments, and other organizations in the various sectors of U.S. society. Questionnaires were mailed to 1,400 small businesses--over 70 percent responded; the 500 largest industrial corporations--over 80 percent responded; all State governments and State education agencies--92 and 100 percent responded,

respectively; and 400 associations in the building and construction industry--over 70 percent responded. The questionnaires used are appended to their respective chapter in this report. We contracted with a public opinion polling organization to conduct a survey of consumer views on the metric system. Relevant legislation was also reviewed.

We also discussed metrication with officials of Canada's metric commission and the United Kingdom's metrication board as well as with several Canadian and British industry representatives. Pertinent, available documents on metrication in Australia, Canada, New Zealand, and the United Kingdom were reviewed. The data we obtained was not evaluated in detail for its validity.

Further, we had a group of consultants knowledgeable in various fields but having different views on metrication review our tentative findings and conclusions. The positions taken in this report, however, are those ultimately arrived at by the General Accounting Office. Following is a listing of these consultants and their affiliation at the time we consulted with them.

--Dr. George Ecklund, Director, Office of Economic Research, U.S. International Trade Commission

--Mr. Thomas A. Hannigan, Administrative Assistant to the International Secretary, International Brotherhood of Electrical Workers

--Dr. Robert Johnson, Vice President Engineering, Burroughs Corporation

--Dr. Lee Richardson, President, Consumer Federation of America

--Mr. Roy P. Trowbridge, Director, Engineering Standards, General Motors Corporation

--Dr. Robert C. Turner, Professor, Graduate School of Business, Indiana University

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We wish to express our appreciation to those, both in the private and public sectors, that helped us during the course of our study. They are too numerous to thank personally. The associations, companies, organizations, and governmental agencies who contributed information for this report are listed in Annex I.

CHAPTER 2

THE METRIC SYSTEM

CHAPTER 2

THE METRIC SYSTEM

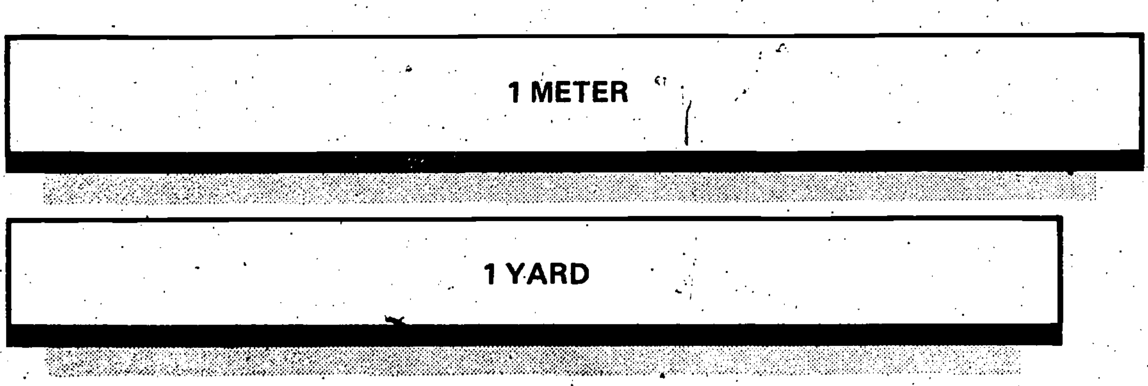
Although many Americans have probably heard or seen references to metric terms or units, they are probably unfamiliar to a large extent with the metric system and its units. The degree of knowledge of any measurement system will vary by individual. Accountants, homemakers, police officers, or lawyers in their day-to-day activities probably use only a few measurement units. On the other hand, chemists, physicists, astronomers, and engineers are concerned with a much greater number of units, many of which would seem complex and technical to large parts of the population.

The first section of this chapter is a discussion of the metric units that the majority of the general public may use and see during their day-to-day activities if the United States converts to the metric system. The second section is a brief description of the system's general structure.

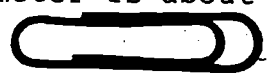
METRIC UNITS FOR EVERYDAY USE

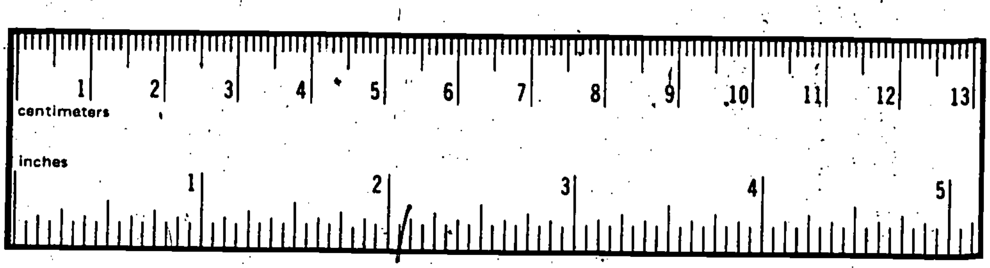
If metric becomes the predominant measurement system in the United States, most Americans probably will be concerned with only a few of the units. The more commonly used units would be the meter, liter, gram, degree Celsius, pascal, and joule. Also, the prefixes milli (1/1,000), centi (1/100), and kilo (1,000) would commonly be used with some of the units to form multiples and submultiples of the units. For example, kilo could be added to gram to form kilogram (1,000 grams). Below is a discussion of how these units compare to the customary units that they would probably replace.

The meter would replace the yard as a measurement of length. A meter is slightly longer than a yard, about 1.1 yards or about 39 inches. The figure below shows the comparative sizes of a yard and a meter.



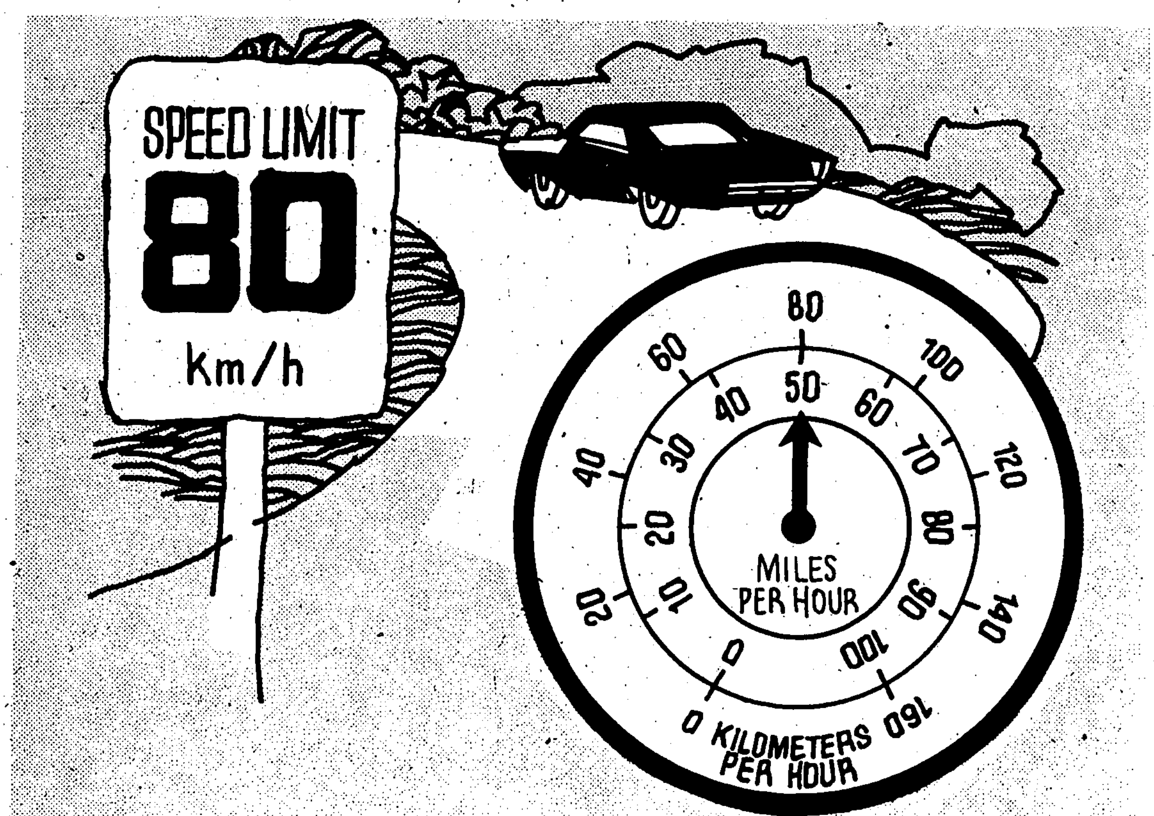
(COMPARATIVE SIZES ARE SHOWN)

Millimeters and centimeters would be used instead of inches and feet. A millimeter is about the diameter of the wire used in a paper clip  while a centimeter is a little more than the width of a paper clip, or about 0.4 inch. About 2.54 centimeters, or 25.4 millimeters, equal an inch. A foot is slightly longer than 300 millimeters, or 30 centimeters.

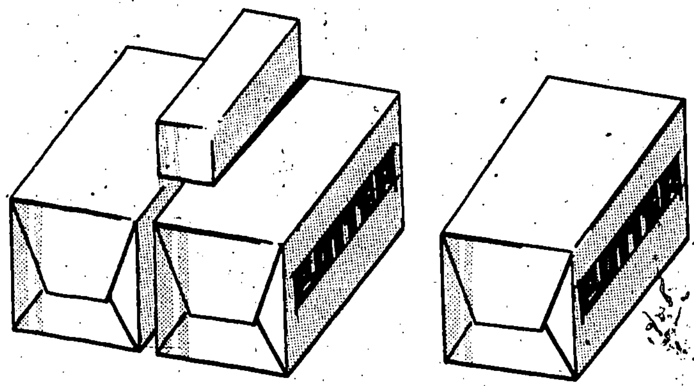


(NOT TO SCALE)

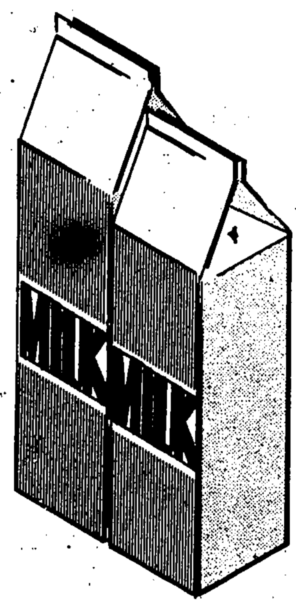
Kilometers would be used for distances in place of miles. A kilometer is somewhat further than half a mile, or about 0.6 miles. Speed would be expressed in kilometers per hour. The national 55-miles-per-hour speed limit, for instance, would probably become 90 kilometers per hour, which is about 1-mile-per-hour faster. In the example illustrated below, 80 kilometers per hour is equal to about 50 miles per hour.



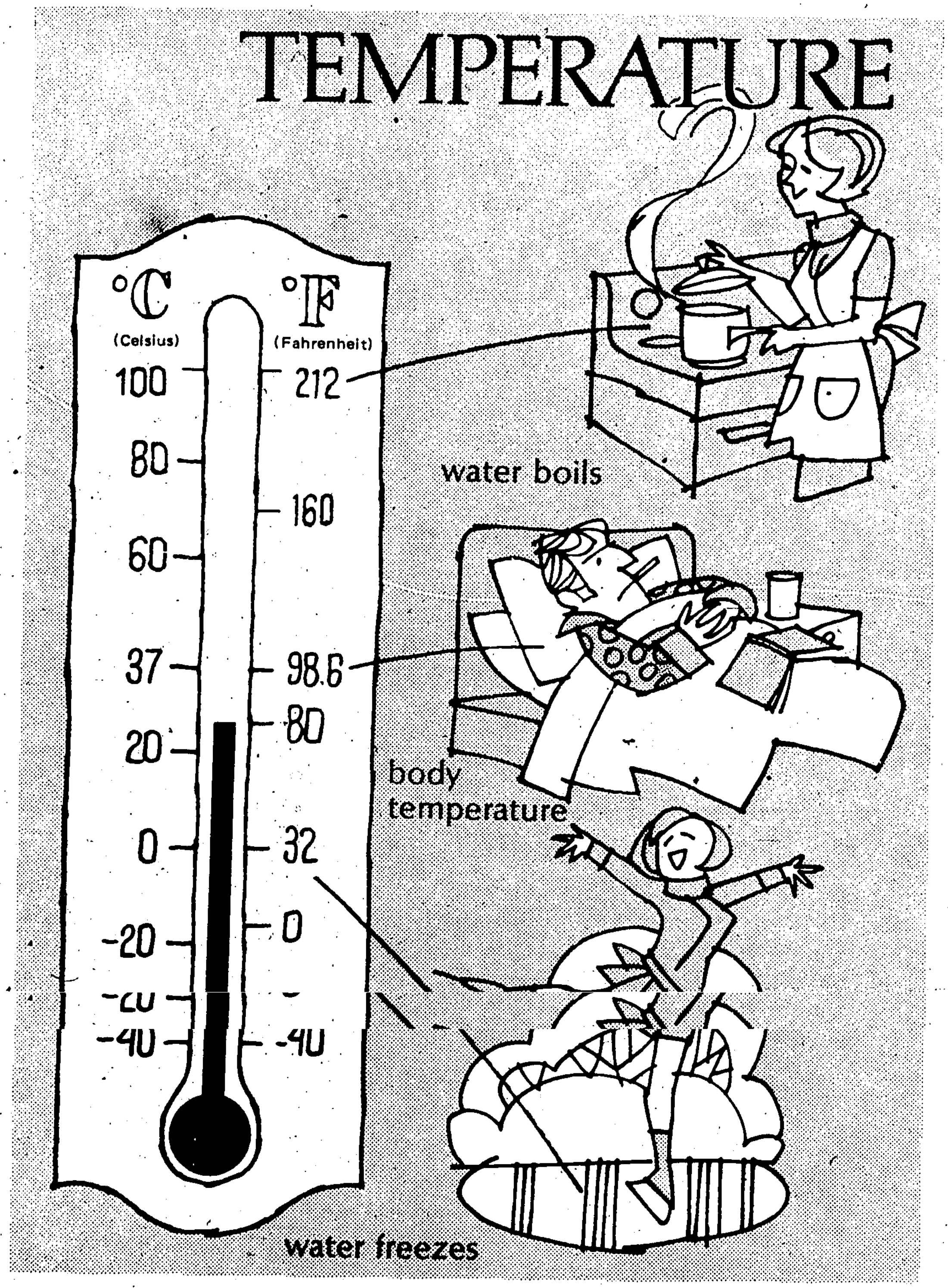
The kilogram and gram would be the units for weight instead of the pound and ounce. A kilogram equals about 2.2 pounds and would be used for larger items. Grams would be used for weighing smaller items. There are slightly more than 28 grams in an ounce. One gram weighs about the same as a paper clip.



Liters would replace gallons and quarts for volume. A liter is about 6 percent more than a quart. A tankful of gas that may have been 20 gallons would be 76 liters. A liter of milk would probably take the place of the quart container. A gallon of paint would probably be supplanted by a 4-liter can. Milliliters would be used for smaller volume. A half-pint container may be replaced by a 250-milliliter container.



Temperatures would be given in degree Celsius (formerly centigrade) rather than in degree Fahrenheit. Water freezes at zero degrees Celsius and boils at 100 degrees Celsius. Body temperature is 37 degrees rather than 98.6 degrees.



A temperature of 20 degrees Celsius would be a mild day (68 degrees Fahrenheit). A temperature of 10 degrees Celsius would be about 50 degrees Fahrenheit. Forty degrees Celsius would be heat wave conditions (104 degrees Fahrenheit). The following depicts the difference between 25 degrees in Celsius and Fahrenheit.

25 DEGREES FAHRENHEIT

25 DEGREES CELSIUS

Degrees Celsius can be converted to degrees Fahrenheit by multiplying the Celsius temperature by 9/5 and then adding 32. Degrees Fahrenheit can be converted to degrees Celsius by multiplying degrees Fahrenheit by 5/9 after subtracting 32.

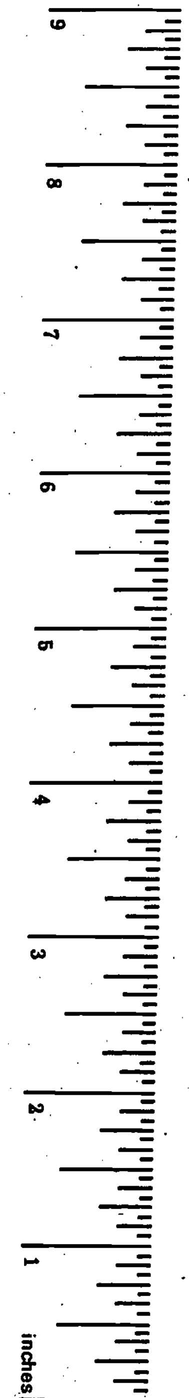
Kilopascals would replace pounds per square inch for pressure. A tire with an air pressure of 30 pounds per square inch would have about 210 kilopascals of air pressure. Pounds per square inch can be converted to kilopascals by multiplying pounds per square inch by a factor of 6.895.

Joules would be counted rather than calories. Converting to metric would mean that a piece of pie with 750 calories would have about 3,000 joules. Calories can be converted to joules by multiplying calories by a factor of 4.19.

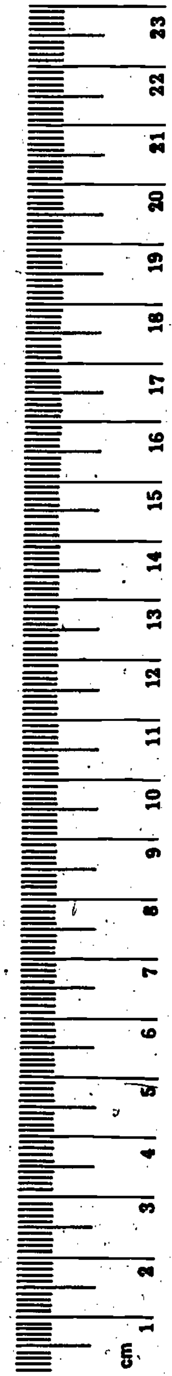
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
		MASS (weight)		
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	metric tons	t
		VOLUME		
tsp	teaspoons	5	milliliters	mL
Tbsp	tablespoons	15	milliliters	mL
fl oz	fluid ounces	30	milliliters	mL
c	cups	0.24	liters	L
pt	pints	0.47	liters	L
qt	quarts	0.95	liters	L
gal	gallons	3.8	liters	L
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
		TEMPERATURE (exact)		
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

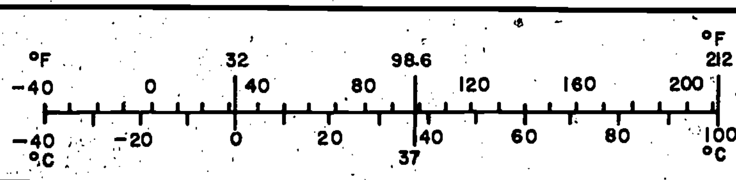


Note: This chart is based on National Bureau of Standards' publications.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
mm	milliliters	0.04	inches	in
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
		AREA		
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10 000 m^2)	2.5	acres	
		MASS (weight)		
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	metric tons (1000 kg)	1.1	short tons	
		VOLUME		
mL	milliliters	0.03	fluid ounces	fl oz
L	liters	2.1	pints	pt
L	liters	1.06	quarts	qt
L	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
		TEMPERATURE (exact)		
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



Note: This chart is based on National Bureau of Standards' publications.

THE METRIC SYSTEM

The metric system specified by the Metric Conversion Act of 1975 is the International System of Units (SI), established by the General Conference on Weights and Measures in 1960 and interpreted or modified for the United States by the Secretary of Commerce. The General Conference has made some changes in the SI system since 1960. Further requirements or changes are anticipated as the need arises. The Assistant Secretary of Commerce for Science and Technology, who was delegated by the Secretary of Commerce the responsibility for interpreting the SI system for U.S. use, in carrying out this responsibility has incorporated these changes and made some other slight variations.

The general characteristics of the system have remained the same. All units are derived from seven base units, and there is only one recognized unit for each physical quantity--the meter for length, the kilogram for mass, etc. A major characteristic is that the SI system is decimal--based on 10. The multiples and submultiples are formed by adding any 1 of 16 prefixes to the units, resulting in such terms as the millimeter and centimeter. Each unit and prefix has an internationally agreed symbol which, according to the agreement, was to be the same in any language.

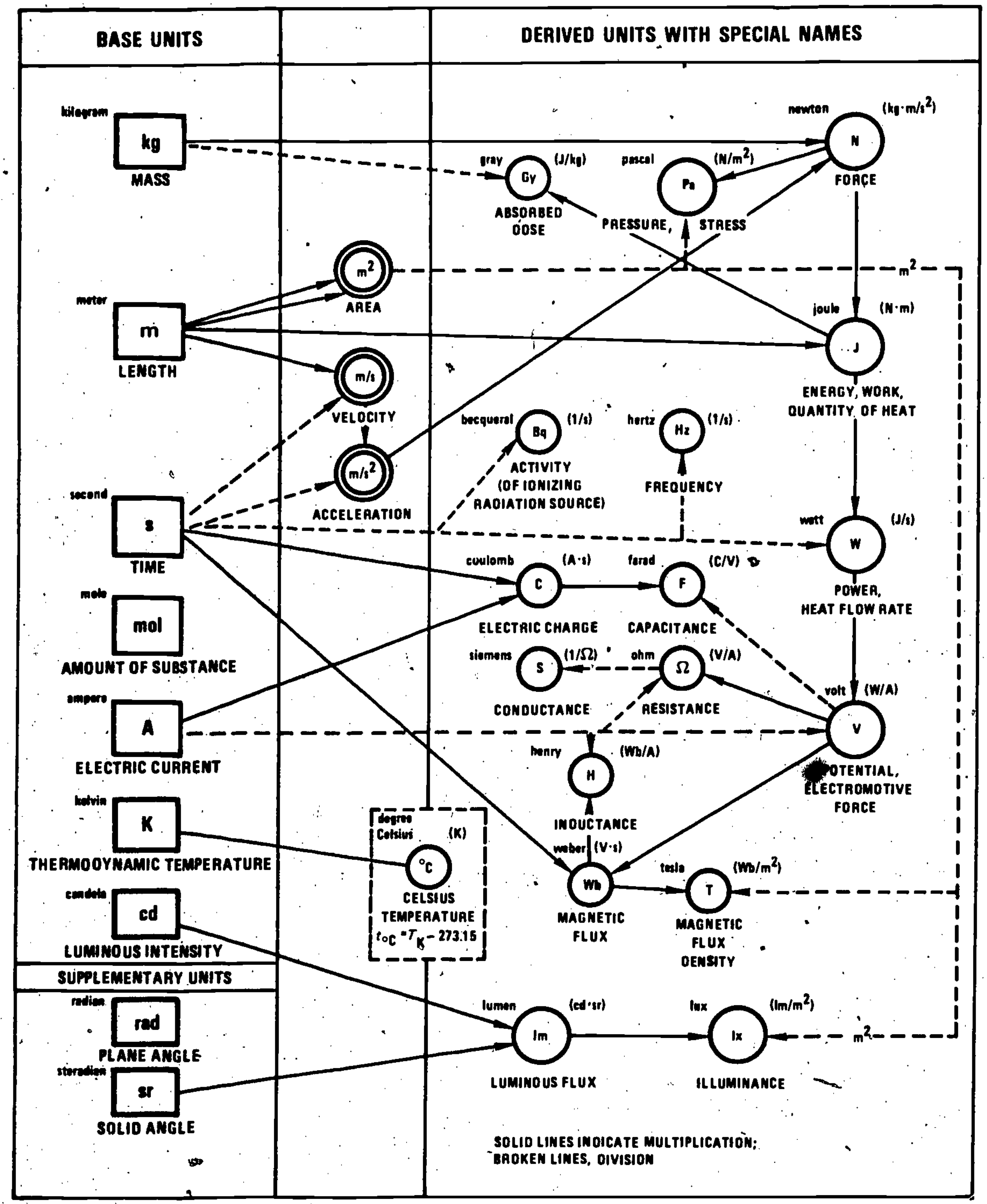
General structure of the SI system

The SI system is made up of three categories of measurement units: base, supplementary, and derived. The 16 prefixes indicating decimal multiples and submultiples are used with these units to move up and down the scale of measurement. Currently, there are seven base units, two supplementary units, and numerous derived units. In addition, some non-SI units may be used with SI units. However, not everyone has to be concerned with all these units or prefixes.

Base and supplementary units

The base units serve as the foundation for the SI system. Base units are not more basic or fundamental than the other SI units but rather are considered to have independent dimensional or measurement properties. They form the base from which the other units can be mathematically derived. For example, a meter--the base unit for length--multiplied by a meter is a square meter, the unit for area. In addition to the seven base units, there are two units about which the General Conference is undecided as to whether they should be base units or derived units. They are called supplementary units and may be treated either way.

RELATIONSHIPS OF SI UNITS WITH NAMES



The base and supplementary units with their symbols are listed below.

Base Units

Quantity	Base Unit name	Symbol
length	meter	m
mass	kilogram	kg
time	second	s
electric current	ampere	A
thermodynamic temperature	kelvin	K
amount of substance	mole	mol
luminous intensity	candela	cd

Supplementary Units

Quantity	Supplementary Unit	Symbol
plane angle	radian	rad
solid angle	steradian	sr

Derived units

Measurement units for all other quantities are mathematically derived from the above nine units according to the rules of algebra. Eighteen of the derived units have been given special names rather than being expressed in terms of other units. These special-named, derived units are shown on the following page.

SI derived units with special names

Quantity	SI unit: Name	Symbol	Expression in terms of other units	Expression in terms of SI base units
frequency	hertz	Hz		s^{-1}
force	newton	N		$m \cdot kg \cdot s^{-2}$
pressure, stress	pascal	Pa	N/m^2	$m^{-1} \cdot kg \cdot s^{-2}$
energy, work, quantity of heat	joule	J	$N \cdot m$	$m^2 \cdot kg \cdot s^{-2}$
power, radiant flux	watt	W	J/s	$m^2 \cdot kg \cdot s^{-3}$
quantity of electricity, electric charge	coulomb	C	$A \cdot s$	$s \cdot A$
electric potential, potential difference, electromotive force	volt	V	W/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-1}$
capacitance	farad	F	C/V	$m^{-2} \cdot kg^{-1} \cdot s^4 \cdot A^2$
electric resistance	ohm	Ω	V/A	$m^2 \cdot kg \cdot s^{-3} \cdot A^{-2}$
conductance	siemens	S	A/V	$m^{-2} \cdot kg^{-1} \cdot s^3 \cdot A^2$
magnetic flux	weber	Wb	$V \cdot s$	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-1}$
magnetic flux density	tesla	T	Wb/m^2	$kg \cdot s^{-2} \cdot A^{-1}$
inductance	henry	H	Wb/A	$m^2 \cdot kg \cdot s^{-2} \cdot A^{-2}$
Celsius temperature	degree Celsius	°C		K
luminous flux	lumen	lm		$cd \cdot sr$
illuminance	lux	lx	lm/m^2	$m^{-2} \cdot cd \cdot sr$
activity (of a radionuclide)	becquerel	Bq		s^{-1}
absorbed dose, specific energy imparted, kerma, absorbed dose index	gray	Gy	J/kg	$m^2 \cdot s^{-2}$

The newton, for instance, is the force required to accelerate 1 kilogram 1 meter per second squared.

The numerous other derived units are expressed in terms of other units. Examples of these are given in the following tables.

Examples of SI derived units expressed by means of special names

Quantity	SI unit		
	Name	Symbol	Expression in terms of SI base units
dynamic viscosity	pascal second	Pa · s	$m^{-1} \cdot kg \cdot s^{-1}$
moment of force	newton meter	N · m	$m^2 \cdot kg \cdot s^{-2}$
surface tension	newton per meter	N/m	$kg \cdot s^{-2}$
power density, heat flux density, irradiance	watt per square meter	W/m^2	$kg \cdot s^{-3}$
heat capacity, entropy	joule per kelvin	J/K	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$
specific heat capacity, specific entropy	joule per kilogram kelvin	J/(kg · K)	$m^2 \cdot s^{-2} \cdot K^{-1}$
specific energy	joule per kilogram	J/kg	$m^2 \cdot s^{-2}$
thermal conductivity	watt per meter kelvin	W/(m · K)	$m \cdot kg \cdot s^{-3} \cdot K^{-1}$
energy density	joule per cubic meter	J/m^3	$m^{-1} \cdot kg \cdot s^{-2}$
electric field strength	volt per meter	V/m	$m \cdot kg \cdot s^{-3} \cdot A^{-1}$
electric charge density	coulomb per cubic meter	C/m^3	$m^{-3} \cdot s \cdot A$
electric flux density	coulomb per square meter	C/m^3	$m^{-2} \cdot s \cdot A$
permittivity	farad per meter	F/m	$m^{-3} \cdot kg^{-1} \cdot s^4 \cdot A^2$
permeability	henry per meter	H/m	$m \cdot kg \cdot s^{-2} \cdot A^{-2}$
molar energy	joule per mole	J/mol	$m^2 \cdot kg \cdot s^{-2} \cdot mol^{-1}$
molar entropy, molar heat capacity	joule per mole kelvin	J/(mol · K)	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1} \cdot mol^{-1}$
exposure (x and γ rays)	coulomb per kilogram	C/kg	$kg^{-1} \cdot s \cdot A$
absorbed dose rate	gray per second	Gy/s	$m^2 \cdot s^{-3}$

Examples of SI derived units expressed in terms of base units

Quantity	SI unit	
	Name	Symbol
area	square meter	m^2
volume	cubic meter	m^3
speed, velocity	meter per second	m/s
acceleration	meter per second squared	m/s^2
wave number	1 per meter	m^{-1}
density, mass density	kilogram per cubic meter	kg/m^3
current density	ampere per square meter	A/m^2
magnetic field strength	ampere per meter	A/m
concentration (of amount of substance)	mole per cubic meter	mol/m^3
specific volume	cubic meter per kilogram	m^3/kg
luminance	candela per square meter	cd/m^2

Prefixes

The metric system is decimal because prefixes are used to indicate multiples and submultiples of 10. For example, kilo (1,000) can be combined with meter to form kilometer (1,000 meters). Milli (1/1,000 or 0.001) also can be used with meter to form millimeter (1/1,000 of a meter). The 16 approved prefixes are listed on the following page.

SI Prefixes

Multiplication Factors		Prefix	SI Symbol
1 000 000 000 000 000 000	= 10^{18}	exa	E
1 000 000 000 000 000	= 10^{15}	peta	P
1 000 000 000 000	= 10^{12}	tera	T
1 000 000 000	= 10^{9}	giga	G
1 000 000	= 10^{6}	mega	M
1 000	= 10^{3}	kilo	k
100	= 10^{2}	hecto	h
10	= 10^{1}	deka	da
0.1	= 10^{-1}	deci	d
0.01	= 10^{-2}	centi	c
0.001	= 10^{-3}	milli	m
0.000 001	= 10^{-6}	micro	μ
0.000 000 001	= 10^{-9}	nano	n
0.000 000 000 001	= 10^{-12}	pico	p
0.000 000 000 000 001	= 10^{-15}	femto	f
0.000 000 000 000 000 001	= 10^{-18}	atto	a

It should be noted that the kilogram, rather than the gram, is used as the SI unit. It is the only SI unit with a prefix. Because double prefixes are not to be used, the above set of prefixes should be used with the gram rather than the kilogram.

Approved non-SI units

Certain units which are not part of the SI system are used so widely that the Assistant Secretary of Commerce considers it impractical to abandon them. The minute (of time), hour, day, liter, metric ton, and hectare; and the degree, minute, and second of angle are acceptable for continued use in the United States with SI units. These are often considered more practical for everyday use. For example, since the second is the SI base unit for time, 1 hour would be 3.6 kiloseconds (3,600 seconds). Obviously it is more practical to use hour.

The use of 10 other non-SI units is accepted for a limited time in the United States, subject to future review. These include the internationally used nautical mile (1,852 meters), the knot (1 nautical mile per hour), and the bar (100 kilopascals). Under the SI system, these would be replaced by the kilometer, kilometer per hour, and the kilopascal. No time frames have been established for phasing out these units.

Interpreting and modifying the SI system for U.S. use

The Assistant Secretary published the initial interpretation and modification of the SI system for U.S. use in the December 10, 1976, "Federal Register." 1/ This was later amended slightly in the October 26, 1977, "Federal Register" to adhere to recent changes approved by the General Conference on Weights and Measures. The National Bureau of Standards first published guidelines for use of the metric system on June 19, 1975, before the Metric Conversion Act, at the request of the U.S. Commissioner of Education. The Education Amendments Act of 1974 (see ch. 24) also had specified for U.S. use the SI system as interpreted and modified by the Secretary of Commerce. The Secretary delegated the responsibility to NBS.

The Assistant Secretary has only slightly modified the SI system for U.S. use. For example, the hectare is an approved non-SI unit which can continue to be used with SI units. The General Conference on Weights and Measures considers the hectare to be a non-SI unit that is approved for a limited time subject to further review. This is a small change because the General Conference established no time frame for phasing out the hectare. Other modifications were to specify use of the "er" spelling of meter and liter rather than the international "re" spelling and the capital "L" rather than the internationally agreed lowercase "l" as the symbol for liter.

These modifications have been controversial. Some would prefer that the United States adopt the SI system in its entirety, with the internationally agreed spelling and symbols.

1/The "Federal Register" is a document published daily, Monday through Friday, by the General Services Administration. It provides a uniform system for making regulations and legal notices issued by Federal agencies available to the public. These include Presidential proclamations and Executive orders, Federal agency documents having general applicability and legal effect, documents required to be published by act of Congress, and other Federal agency documents of public interest.

For example, the automobile industry prefers the re spelling of liter and meter. Others believe that such changes are needed if the system is to be used in the United States. For example, the Assistant Secretary determined that the er spelling for meter and liter would be used because it would be more familiar to most Americans. The capital L was specified as the symbol for liter because the lowercase l on the typewriter and in print is little or no different from the number "1." This could cause confusion. The script "l," a possible alternative, is not on many typewriters and would cause difficulties in typeset material, electronic data processing, and teleprinting.

Desirability of some SI units

Some disagreements are developing over the desirability of certain SI units. The pascal, the SI unit for pressure, appears to be the major unit of controversy. Some groups prefer other metric units for pressure, such as the bar, millimeters of mercury, and kilogram force per square centimeter.

The major objection to the pascal is that it is too small of a unit with which to work. It takes about 1,000 pascals to equal 1 pound per square inch. A bar, for instance, is equal to 100,000 pascals or about 14.5 pounds per square inch.

Another objection is that metric units, such as the bar, are more internationally accepted than the pascals because many metric countries use them. The bar and millimeter of mercury are also used to some extent in this country. In addition, some believe that a change to pascal will increase confusion and the chance for error. The expected confusion would result because new units are being used and the pascal is considered too abstract or difficult to visualize.

CHAPTER 3

THE DEBATE

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THE DEBATE

Whether the United States should convert to the metric system has been debated almost since the Nation's birth. The debate has centered basically around the advantages and disadvantages. Many of these arguments are as old as the debate itself.

The following is a brief description of the generally ascribed advantages and disadvantages. We have not evaluated these on an overall basis; however, they are addressed in the following sections of this report as they relate to the various segments of our economy.

ASCRIBED ADVANTAGES

Proponents of U.S. conversion to the metric system generally support conversion because of the following cited advantages.

The metric system is a better measurement system

The metric system was developed by scientists. It is a planned, more rational, simple, and coherent system. There are only a few basic units--one for length, one for weight, etc.--from which all other units are derived in a coherent manner. Prefixes allow expansion and contraction of all units to fit the full measurement range with a base number of 10. In addition, metric has a more fundamental relationship to human anatomy. People have 10 fingers and have long learned to count on them.

Because the metric system is based on 10, it is easier to compute numbers.. In many cases, a zero is added or a decimal point is moved. For example, to calculate the number of meters in 187 kilometers, simply multiply by 1,000 which moves the decimal point three places to the right. On the other hand, calculating the number of yards in 187 miles requires the knowledge that 1,760 yards are in a mile; 1,760 is then multiplied by 187.

Calculations are made easier because there is no need to remember how many inches are in a foot; feet, in a yard; cubic inches, in a gallon; or whether an ounce is fluid or avoirdupois. The metric system also distinguishes between mass (the kilogram) and force (the newton) which has confused students for many years under the customary system.

As a result, the metric system is easier to teach, learn, and use. It results in fewer errors. Schools would have more time to teach other subjects; engineers, architects, and others would save time and make fewer errors.

The United States would join the rest of the world in a common measurement language

Nearly all other countries have adopted or are adopting the metric system. The United States has remained customary primarily because it trades mostly with English-speaking countries. Now, they are converting to the metric system.

If the United States converts, its scientists, businessmen, educators, and government officials speaking a common measurement language could better communicate not only with each other but with their counterparts in other countries. As it is now, American scientists use the metric system while engineers use the customary system. Transfer of data and technological advances would be facilitated.

The United States would fortify its position as a leader by joining the rest of the world in a common measurement language. There would be one less hangup in relations with other nations; fewer obstacles would help in setting international standards. Conversion to the metric system should help the United States win acceptance of its ideas.

U.S. military allies are either metric or committed to metrication. Therefore, if the United States converts, military coordination and logistics would be simplified.

Travelers and other U.S. citizens who have dealings abroad are handicapped to the extent that they are unfamiliar with the commonly accepted measurement language. Metrication would eliminate conversion problems.

The United States can better do its part to aid the development of other nations if it adopts the measurement language that is familiar to almost all of them. The use of a simple and practical metric system by all nations would be a great contribution to civilized life. If the United States does not convert to the metric system, it will be "an island in a metric sea."

Conversion would improve or help maintain the U.S. foreign trade position

The U.S. economy today, as never before, depends on trading raw materials, manufactured products, even technological ideas with countries that have changed to the metric system

or have committed themselves to do so. The United States puts itself at a competitive disadvantage by using a measurement system different from that of the world market. U.S. exports may not be as acceptable if they are in the customary system. Customers would be unfamiliar with the system and may be concerned about replacement parts. International standards, that are increasingly metric, have been cited as potential nontariff barriers which could hamper the export of U.S. goods abroad.

The United States is placed at a competitive disadvantage with other industrial nations which are writing trade agreements on the basis of metric measurements. The emerging nations of Asia and Africa--representing vast new markets--also deal primarily in metric units. A U.S. exchange of its measurement system for that of other metric countries would help insure the success of its future trade relationships; therefore, conversion becomes advantageous.

U.S. companies that want to make metric products for sale in the United States or foreign markets may find it advantageous to build the plant abroad and employ foreign workers familiar with the metric system. Exporting of jobs to metric countries is already a problem.

Conversion would provide opportunities for worthwhile changes

The processes involved in a changeover to the metric system would provide opportunities and possibly the impetus needed to examine how things are done and to "clean house." Many changes would probably go beyond what is necessary. Faced with the task of doing things differently, creative people would take the opportunity to do things better. Metrication could stimulate invention and innovation. It is a "once in a lifetime opportunity."

During adjustments to the new measurements, many of the varieties of nuts and bolts could be eliminated and the number of product sizes reduced. This would in turn reduce the number of different items in inventory.

An opportunity would exist to improve the technical quality of building codes and other engineering standards. Schools would have an added reason to revamp textbooks and curricula.

Many of these opportunities may be available under the customary system but are unlikely to be taken advantage of because of a reluctance to make changes unless necessary.

These changes could result in significant cost savings and product improvement.

Conversion would stimulate the economy

The new economic activity involved in a changeover to the metric system would be a stimulus comparable to the activity which took place several years ago in the space program. This would include purchase of metric tools, equipment, scales, micrometers, books, conversion charts, and the services required to adjust or adapt scales and other equipment.

Conversion is inevitable and would cost more later

U.S. conversion is inevitable because nearly all other countries are metric, and many large U.S. firms are converting or will be converting. The "ripple effect" of their conversion will eventually bring about metrication of the Nation. Thus, the Nation is already heading toward conversion in an unorganized way. Conversion will never cost less than it will right now. Postponing the decision to change transfers a greater burden to future generations of Americans.

Small businesses and self-employed craftsmen would benefit from a coordinated conversion program. As [illegible] they are being left behind by some big firms that have the expert staffs and international connections to adapt independently to the increasing worldwide demand for metric goods.

ASCRIBED DISADVANTAGES

The disadvantages frequently attributed to metric conversion generally fall into one of the following categories.

The customary system is a better measurement system

The U.S. customary system is tailored to meet practical everyday needs of human beings. It is firmly established, and it is not obsolete or complex. It came into being by natural selection. Although use of the metric system has been legal in the United States since 1866, the customary system survives because it meets a need. For most purposes, the inch, foot, ounce, pound, and gallon are the most satisfactory units. No metric units are comparable, and equivalent metric measurements involve more digits and thus are less convenient and offer more chances for errors.

Customary units are related to everyday experience. For example, a person's foot is about a foot long. Customary

quantities are more understandable. The meter, about 4 inches longer than the yard, is too great a length for general application, and the gram is too small to be practical. Metric names are more difficult to say and remember.

The human mind through the ages has resorted to binary division (dividing in halves) as the easiest form of division. Next to halves, is thirds for simplicity, and from the combination of these is derived the common multiple 12, which is found in the division of time and the circle. These common and simple forms of division and multiplication are not found in the metric system. France, the birthplace of the metric system, recognized the logic and convenience of binary division and adopted a modular unit of 1.2 meters, a deviation from 10, because it is divisible into subunits of 200, 300, 400, and 600 millimeters.

The metric system is not as simple as proponents claim. It consists of 7 base units; 2 supplementary units; numerous derived units; 16 prefix multiplication factors; and many rules of application, selection, combination units, usages of selected quantities, equations, conversion, rounding, accuracy, significant digits, interchangeable parts, tolerances, and terminology. The purported logic of the metric unit names is violated by the use of the kilogram, rather than the gram, as the base unit for mass. The basic objection to metric units is that they come in the wrong sizes for people.

Conversion would be enormously expensive

Metric conversion would entail costs for such items as tool and die changes; equipment adjustments; retraining; double inventories; metricating of standards and building codes and other such regulations and laws; and purchases of metric tools, thermometers, scales, and so forth.

Everybody would have to pay for conversion because industry would have an excuse for higher prices; labor, an excuse for higher wages; and government bureaucracies, an excuse for higher appropriations.

People would have to be retrained, and during the retraining period, they would be deprived of invaluable experience--the intuitive feel for measurements on which craftsmen, mechanics, and engineers depend. The result would be a temporary loss of productivity.

If the United States decides to go metric, it is likely to pick the wrong time. No one can guarantee what the economic conditions would be throughout the transition period.

Conversion would cause confusion

The simplest measurement system is the one that people presently know and understand. Changing measurement systems would cause confusion. Consumers would not know whether they are getting their money's worth for things sold by length, volume, or weight. They may not be able to recognize price increases. During the transition, the Nation would be part metric and part customary. Buyers and sellers could get badly out of phase with one another as to the availability and demand for parts.

Dealing with unfamiliar quantities may increase response time and mistakes. This may result in safety hazards.

Conversion would hurt the U.S. economy

Planning and coordinating the conversion of a large, complex, industrial economy, such as that of the United States, would be extremely difficult. Conversion costs would intensify inflationary pressures in a strong economy and would impede and possibly preclude recovery in a slack economy.

The need to redesign, retool, and retrain in the metric system could delay or cancel needed projects. Large amounts of energy may be required to replace or adapt prematurely obsolescent equipment, meters, scales, buildings, etc. Capital to finance metrication and dual inventories would compete with other needs for scarce capital. Small- and middle-sized businesses could not compete with large international corporations for this capital.

Some firms have proposed changes in antitrust laws to allow them to get together for the purpose of planning metrication. Such changes could result in greater economic concentration of firms with less competition.

Imports of metric products would increase because metric products required for U.S. conversion would have to be obtained from other countries. Furthermore, due to the additional costs of conversion, U.S. products would be more expensive than imported products that are already metric. Foreign countries would benefit from broadened markets and new economies of scale due to increased production and lower operating costs. The United States would also be flooded with customary products produced by other countries to meet the continuing demand by the public for goods during the conversion period.

Conversion could be a contributing factor in the premature obsolescence of U.S. manufacturing plants due to the need to retool or replace equipment. Multinational firms may

locate the new plants in foreign countries to take advantage of lower construction costs, lower labor costs, and tax exemptions. The end result would be the loss of construction and production jobs.

<u>There is no need to convert to the metric system</u>

The United States should not risk its industrial success obtained under the customary system by changing to a new system. The system of measurement is not a significant factor in international trade. The factors which influence exports are price, quality, availability, credit, and technology. Other considerations are competition with foreign cartels, government-subsidized industries, and U.S. diplomacy and treaties.

It is unlikely that any country would prohibit U.S. imports on the basis that they are not designed and engineered in metric units because of a fear of reciprocal action by the United States. The U.S. export trade is small compared to its gross national product. Much of the exports are not measurement-sensitive. Foreign considerations do not warrant disruption of the whole economy. Worldwide usage of U.S. customary standards is still much greater than that of metric standards.

Several different national metric systems are in use in the world today. The International System of Units is materially different from the metric system of other nations. There is much evidence that these nations intend to protect their interests and thus are reluctant to adopt SI in its entirety. Even if the United States converts to SI as proposed, still no single worldwide system of measurement would exist.

Many of the advantages of metric conversion are opportunities for change. These exist under the customary system. Many improvements in our way of life have been made in the past under the customary system.

CHAPTER 4

IMPACT ON U.S. TRADE UNCERTAIN

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IMPACT ON U.S. TRADE UNCERTAIN

The extent to which U.S. trade will be affected by the United States becoming predominantly metric or remaining predominantly customary is uncertain. However, at this time the effects of metrication in promoting or deterring trade are considered to be relatively insignificant, and the companies in the forefront of metrication appear to be pursuing conversion for reasons other than a possible favorable impact on trade.

To examine the effects of metrication on U.S. trade, we sent questionnaires to the Fortune 500, discussed the implications with officials of selected industries and Federal agencies, and reviewed applicable literature. This chapter summarizes the results of this examination. Additional comments on the impact of metrication on trade of specific companies are included throughout this report.

IMPACT ARGUMENTS

Proponents of U.S. conversion have spoken of the United States as being isolated in an increasingly metric world. They point out that most countries of the world are presently using the metric system or are converting to its use. They note that the continued acceptability of U.S. products is necessary if the United States is to maintain its stake in world trade. As the world becomes increasingly metric, they state, so do international standards of measurement. While standards can be constructive and necessary, they can sometimes impede international trade, having the effect of protecting against import competition. Consequently, proponents of metrication have argued, U.S. products are or will be discriminated against because they are produced to customary rather than metric standards. In short, if the United States is to maintain a favorable balance in international trade, metrication is necessary. This was the conclusion of the 1971 National Bureau of Standards metric study report.

NBS surveyed exporters and importers of measurement-sensitive goods and estimated that, had the United States gone metric by 1970, exports of measurement-sensitive products in 1975 would have increased by $600 million while imports of such products would have remained about the same. Another estimate of the United States losing as much as $25 billion annually on the world market due to its not being on the metric system has appeared in various pieces of literature on metrication. ($25 billion is about 22 percent of the $115 billion total U.S. exports in 1976.)

Opponents of metrication, or at least those opposed to the Government encouraging or mandating metrication, are likewise concerned with its effects on international trade. Representatives of organized labor believe metrication would put the United States at a distinct trade disadvantage. They argue that generally goods flow from low cost to high priced areas. Thus, conversion would be an additional burden for U.S. goods, since the costs of conversion would have to be added to U.S. produced goods. On the other hand, foreign countries which are already metric would not incur this cost and would also benefit from broadened markets and new economies of scale due to increased production and lower operating costs. Also, foreign-made metric tools, instruments, and equipment urgently needed by U.S. industry would flood the country. The end result would be a mass influx of foreign goods to U.S. markets, resulting in the loss of hundreds of thousands of U.S. jobs.

The increase in domestic production costs due to metrication will, according to organized labor representatives, contribute to the premature obsolescence of many plants. They also maintain that given lower foreign construction costs, exemption from fair labor standards, minimum wage regulations, unemployment compensation, health and safety regulations, environmental standards, etc., and lucrative tax loopholes which make it more profitable for multinationals to relocate and produce abroad, it is very probable that many U.S. companies will relocate in foreign countries. Thus, they say, hundreds of thousands of American jobs will be lost, and consequently, metrication will contribute to the "acceleration of the deindustrialization of the United States."

The argument put forth by representatives of organized labor is based largely on the assumption that the costs of conversion will be substantial--or at least substantial enough to make foreign goods relatively cheaper and/or cause plants to close down. However, the costs of metrication for the United States have not been determined, and it appears that a valid estimate will be difficult to obtain. Few companies have determined the cost of converting and those that have consider the information to be proprietary. One company, however, told us that the actual costs of conversion were considerably less than originally anticipated. Of the large businesses responding to our questionnaire (see ch. 5), 67 percent believed that conversion would be costly. In considering the long-term effect of conversion on prices, however, only 25 percent saw any increase in the price of their products. Of these, only 2 percent believed there would be a major increase.

Similarly, the estimates of exports lost are equally nebulous and their extreme range--the $600-million estimate of NBS to the $10- to $25-billion estimates appearing in various publications--further add to the uncertain effects of metrication.

While the 1971 NBS study was based on substantial analytical data, the $600-million increase in exports projected in that study resulted from weighing estimates of questionable reliability. A Commerce Department official noted that little reliability has been attached to the $600-million estimate. He also believed that to undertake a similar study at present would be an exercise in futility.

It should be noted that our review of the NBS study showed that imports would have increased by about $100 million, thus partially offsetting the $600 million reported increase in exports. While this figure is probably no better than the $600 million, it further points out the uncertainty of the effects of metrication.

According to an official with the Office of the Special Representative for Trade Negotiations, conversion to the metric system would facilitate trade by providing a common measurement language, but measurement has not been a major factor affecting trade. It has been overshadowed by many other factors, such as price, reliability, and reputation. Future metric requirements and standards of foreign countries may have an impact on the marketability of U.S. products. Whether they will or not depends on what the other countries do.

One American National Metric Council official stated that the impact of metrication on international trade constituted a very "nebulous area," and officials of the U.S. Metric Association have said that nobody knows how metrication will affect trade. We would agree with those conclusions. It is difficult, if not impossible, to validly calculate the effects of metrication on U.S. balance of trade when many other factors appear to determine the flow of goods. Nonetheless, given the many allusions to the impact of metrication on trade, it is important to put the various arguments in their proper perspective.

TRADE AND THE U.S. ECONOMY

The significance of the trade issue can be placed in some perspective by noting the following statistics for 1976.

	Gross national product	Exports	Imports	Exports as percent of gross national product
	------------(in billions)-----------			
United States	1,692	115	129	7
European Economic Community	1,475	399	440	27
Japan	549	67	65	12
Canada	171	39	39	23

Source: International Economic Report of the President, January 1977.

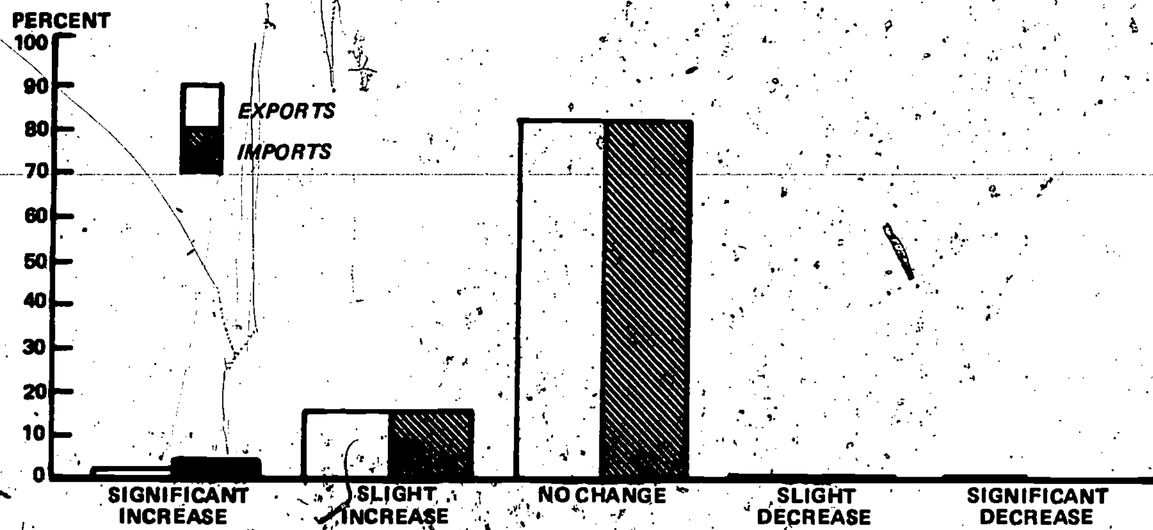
Thus, while trade cannot be considered to be an insignificant factor in the economy, the U.S. economy as a whole is much less dependent on trade than other major industrial nations.

The measurement factor in U.S. trade

It appears that no dramatic increase in measurement-sensitive exports would occur as a result of metrication. Perhaps the most valid conclusion of the 1971 NBS study on trade was that the measurement factor is relatively insignificant in promoting (or deterring) either exports or imports. That conclusion was based on a survey of exporters and importers of measurement-sensitive goods. U.S. exporters of such goods indicated reputation and reliability, superior technology, and high quality of products as the three most important factors promoting sales abroad; while noncompetitive prices, strong local and third country competition, and high tariff duties and shipping costs were indicated as important deterring factors. U.S. importers regarded competitive prices as the most important factor promoting imports, while important deterring factors included no technological advantage, no quality advantage, and high prices.

Our survey of business (ch. 5) showed that the Fortune 500 companies had essentially the same opinion. Although about 60 percent of the respondents believed that conversion to the metric system would facilitate trade through a common measurement language, the respondents did not, as shown in the following chart, expect a significant change in exports or imports as a result of conversion.

Fortune 500 Opinions on Changes In Exports/Imports As A Result Of Metric Conversion



As the following table shows, competitive prices, high quality, superior technology, and a good reputation and reliability were deemed to be of major significance in promoting exports by a majority of the companies while the design and/or manufacture of products in either customary or metric units and/or engineering standards were considered to be of major significance by relatively few of the companies.

Fortune 500
Factors Promoting Exports

Factor	Significance: Major	Significance: Moderate	Significance: Minor	No basis to judge
	-----	----- (percent)	-----	-----
Competitive prices	77	13	3	7
High quality	75	15	3	7
Good reputation and reliability	75	14	3	8
Superior technology	56	20	12	12
Good product maintenance and servicing	47	21	16	16
Growing foreign market	42	30	14	14
Vigorous company export promotion	31	27	25	17
Design/manufacture of products in metric units and/or engineering standards	6	18	48	28
Design/manufacture of products in customary units and/or engineering standards	4	12	56	28

Noncompetitive prices and strong local and/or third country competition were considered of major significance in deterring exports. Again, as the following chart shows, few of the companies considered the design and/or manufacture of products in customary or metric units and/or engineering standards to be of major significance in deterring exports.

Fortune 500
Factors Deterring Exports

Factor	Significance: Major	Moderate	Minor	No basis to judge
	(percent)			
Noncompetitive prices	68	14	7	11
Strong local and/or third country competition	61	19	10	10
High tariffs	51	23	12	14
High shipping costs	44	28	16	12
No technological advantage	34	22	26	18
No quality advantage	32	28	25	15
Nontariff barriers other than measurement standards	25	25	24	26
Design/manufacture of products in metric units and/or engineering standards	4	11	56	29
Design/manufacture of products in customary units and/or engineering standards	3	12	58	27

Other countries' metric laws, regulations, and practices

In the years since 1971, a practice has grown among the countries with which the United States has major trade relations to require imported products to be packaged, labeled, and documented in metric units. The Office of International Finance and Investment within the Department of Commerce has prepared a handbook for U.S. exporters which describes metric laws, regulations, and practices of various countries. Of special interest are those dealing with Canada, the European Economic Community, and Japan, the major trading partners of the United States.

Current Canadian regulations require that declarations of net contents of all packaged consumer goods be stated in metric units and any other declarations be voluntary. In general, Canadian metrication planners seek to maximize the shift to approved metric packaging sizes; but at the present time, the use of metrically dimensioned packages is mandatory only for certain products.

The European Economic Community issued a directive in October 1971 which established the International System of Units as the basic system of weights and measures for all member states. Under the present schedule, after April 1978, all products destined to Community markets must be described both on labels and shipping documents in SI metric units or acceptable alternatives as specified in the directive. The directive does not prohibit dual labeling in both metric and nonmetric units; however, the use of dual labels may be regulated under national laws.

A 1974 directive on packaged liquid foodstuffs established metric container sizes and tolerances for certain prepackaged liquids. Another directive established full tolerances and marking regulations in metrics for various products, including foodstuffs, cosmetics, detergents, polishes, fertilizers, herbicides, and paint. Member states, however, will be allowed to accept imports in other container sizes for its internal domestic use only. Additional directives now under consideration on foodstuffs and common consumer products are designed to prescribe the use of specified metrically sized containers for some products, upon implementation. Directives now in effect on measuring instruments specify the sole use of SI units for the calibration of certain instruments.

A Commerce Department official informed us that at present there is little evidence as to how the various European Economic Community countries will implement the directives and that enforcement may vary from country to country and from product to product. Thus, in considering Community requirements and their impact on trade, three things should be considered: the specific product, the country involved, and the importers' requirements which will reflect commercial practices as well as country and local laws and ordinances.

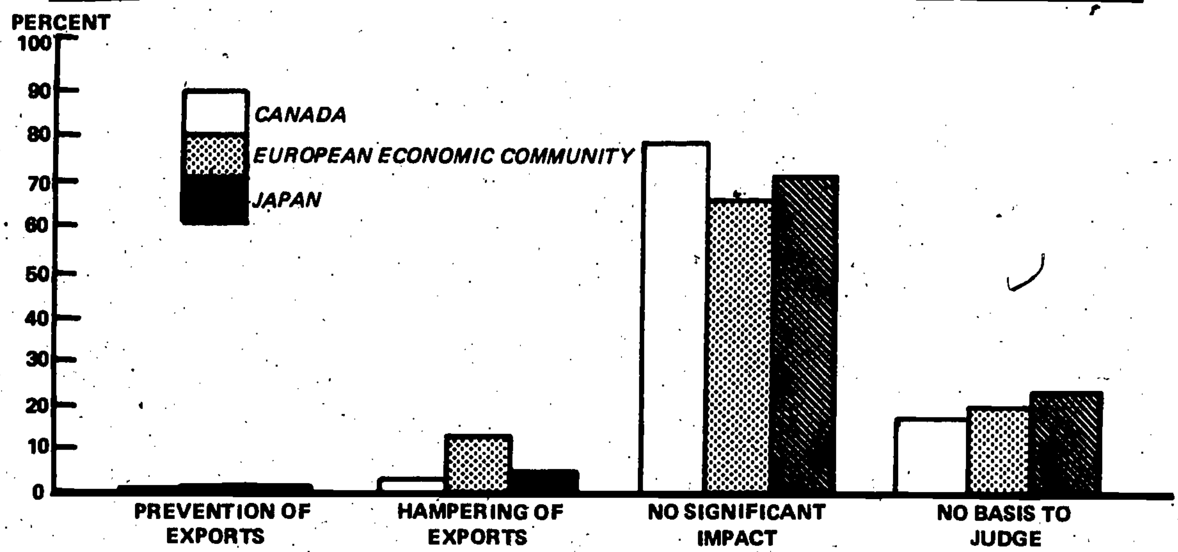
Japan, which officially adopted the metric system in 1951 and completed its changeover in 1966, requires the exclusive use of metric units in the measurement and description of domestic products traded within the country. Japan does not require, however, that imports be packaged, labeled, or otherwise denominated in metric units. Nonetheless, to be eligible for retail sale in Japan, canned, processed, and bottled foodstuffs must be labeled solely in metric units. At the present

time, regulations do not require that measuring instruments be calibrated solely in metric units.

In conclusion, the only standards mentioned above which require packaging in rounded (hard) metric units are those Canadian standards for certain products. Otherwise, import regulations require only that packaging, labeling, and documentation include metric units.

Our survey of large businesses showed that the majority of those responding believed that the import regulations of Canada, the European Economic Community, and Japan, relating to measurement standards, had little significant impact on the export of their products. The following chart shows the businesses' views of the impact of these regulations.

Fortune 500 Opinions on Impact Of Foreign Countries Import Regulations On Exports



Overall, the measurement system is neither considered to promote nor deter foreign trade; nor is it considered to be a major factor for locating a plant overseas.

For 80 percent of the companies, the measurement factor is of no significance in influencing the decision to locate a plant overseas. It was of minor significance to 10 percent of the companies, and only 4 companies, or 1 percent, felt that it was of moderate significance. None viewed it as being of major significance; 9 percent had no basis to judge.

An overall summary of the Fortune 500's posture by each industry on select metric activities, including foreign trade, is contained in appendix IX of chapter 5.

Role of the multinational corporation in metrication--the farm and industrial equipment sector

The farm and industrial equipment sector has been generally recognized as taking a prominent position in converting to the metric system. An official of one company has advanced several characteristics of this industry which perhaps have placed it at the forefront of the movement toward metrication. First, the industry is heavily involved in international commerce. Many of the industry's firms have manufacturing facilities abroad, in countries where international standards are being developed, and these standards are metric standards.

Second, the industry is a highly integrated one; that is, within the industry a large proportion of the manufactured components are produced. Consequently, internal change to industry products can be incorporated with less involvement of other industries.

Third, industry products use many components of somewhat arbitrary and unique shape and dimension, allowing the freedom to use metric dimensions in all areas except those of critical interface with components dimensioned in inches. Several other characteristics of the industry are also mentioned by this official in explaining the sector's activity in moving toward the metric system, and these include the heavy involvement of the industry's firms in the development of standards through technical societies.

As in other industry sectors, the distinction has been made between the two major types of conversion, hard and soft. Major firms within the industry vary as to whether they are approaching metrication from primarily "soft conversion" or "hard conversion."

As stated previously, the large producers of farm and industrial equipment are heavily engaged in international trade, and often they have manufacturing and marketing operations throughout the world. Significantly, however, none of the major firms we contacted believed that metrication would make much difference as far as exports are concerned. Our survey of large businesses elicited essentially the same opinion from some 40 farm and industrial firms that responded. Although 27 of the respondents believed that conversion to the metric system would facilitate trade, the respondents did not expect a significant change in exports.

Twenty-five respondents believed that their exports would not change as a result of metrication, 13 saw a slight increase, and the remaining 2 were equally divided in their opinions between a significant increase and a significant decrease.

As did the Fortune 500 in general, the farm and industrial equipment companies responding to our survey considered other factors as being more significant than measurement units in promoting or deterring exports. As the following charts show, only a small percentage considered the measurement units as being of major significance. A greater percentage of the farm and industrial equipment companies considered measurement to be of moderate significance than did the Fortune 500 in general. Their views on the factors promoting and deterring exports are shown on the following tables.

Farm and Industrial Equipment Companies
Factors Promoting Exports

Factor	Significance			No basis to judge
	Major	Moderate	Minor	
	(percent)			
Competitive prices	77	23	-	-
High quality	79	18	3	-
Good reputation and reliability	85	15	-	-
Superior technology	71	26	3	-
Good product maintenance and servicing	79	21	-	-
Growing foreign market	38	51	8	3
Vigorous company export promotion	32	45	18	5
Design/manufacture of products in metric units and/or engineering standards	8	33	38	21
Design/manufacture of products in customary units and/or engineering standards	8	21	55	16

Farm and Industrial Equipment Companies
Factors Deterring Exports

Factor	Significance: Major	Significance: Moderate	Significance: Minor	No basis to judge
	----------------	(percent)	----------------	
Noncompetitive prices	63	29	3	5
Strong local and/or third country competition	62	22	13	3
High tariffs	54	35	8	3
High shipping costs	38	43	16	3
No technological advantage	39	19	28	14
No quality advantage	33	28	28	11
Nontariff barriers other than measurement standards	25	39	22	14
Design/manufacture of products in metric units and/or engineering standards	3	22	54	22
Design/manufacture of products in customary units and/or engineering standards	5	14	62	19

According to one major producer, measurement is of no consequence in its product sales; and no increase in the company's exports is foreseen due to metrication. The major reason for that company going metric is that it is easier to operate in one measurement system than in two. The company is confident that it can go metric without having any bearing on its customers.

A high official in the overseas division of another major producer noted that metrication would not have much effect on exports. It may make the exchange of goods more convenient, especially after worldwide standards come into use, but

"foreigners will continue to buy the company's products for the same reason, namely that they were reliable, or that the price was right."

Another official, the metric coordinator of that same company, believed that measuring the impact of metrication on international trade was guesswork.

CONCLUSIONS

Companies in the forefront of metrication appear to be pursuing conversion for reasons other than a possible favorable impact on trade.

The frequently cited dollar losses in exports due to the United States not being on the metric system are often based on assumptions and estimates with questionable validity or reliability.

The effect of metrication in promoting or deterring trade would appear to be relatively insignificant. Reliability, technology, quality, prices, and tariffs were factors cited as being much more important in promoting or deterring exports than the measurement factor. As far as we can ascertain at this time, the extent to which U.S. trade will be affected, either in the short or long term, by a U.S. decision to become predominantly metric or remain predominantly customary, cannot be determined.

CHAPTER 5

SURVEY OF BUSINESSES' OPINIONS ON METRICATION

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SURVEY OF BUSINESSES' OPINIONS ON METRICATION

To gain some insight into the opinions of business on the impact and extent of metric conversion, we mailed questionnaires (See apps. I and II), which we pretested, to 1,900 businesses in the United States. One followup letter and a mailgram were sent to encourage greater response.

The 1,900 businesses comprised three groups as follows:

Group	Description
I--500 large corporations	Corporations listed by Fortune Magazine--The Fortune 500.
II--400 businesses	Businesses selected randomly from a membership listing provided by the National Small Business Association.
III--1,000 businesses	Firms taken from a listing of small businesses purchased from Dependable Lists, Inc., a commercial firm.

About 83 percent of the 500 large firms responded while 84 percent and 72 percent responded from the sample of 400 and 1,000 small businesses, respectively. (See apps. III through V for a discussion of samples and response rates.)

In the small business area we also contacted a number of small business associations and the Small Business Administration to obtain their views on the impact of metrication on small business.

THE FORTUNE 500

The Fortune 500 list is compiled by Fortune magazine. It is comprised of the 500 largest industrials that derive more than 50 percent of their revenues from manufacturing and/or mining. The list excludes privately held companies that do not publish financial statements. The criteria for "largest" is determined by a company's annual sales.

The list is further broken down by industry code as shown in appendix III. For a selected number of these

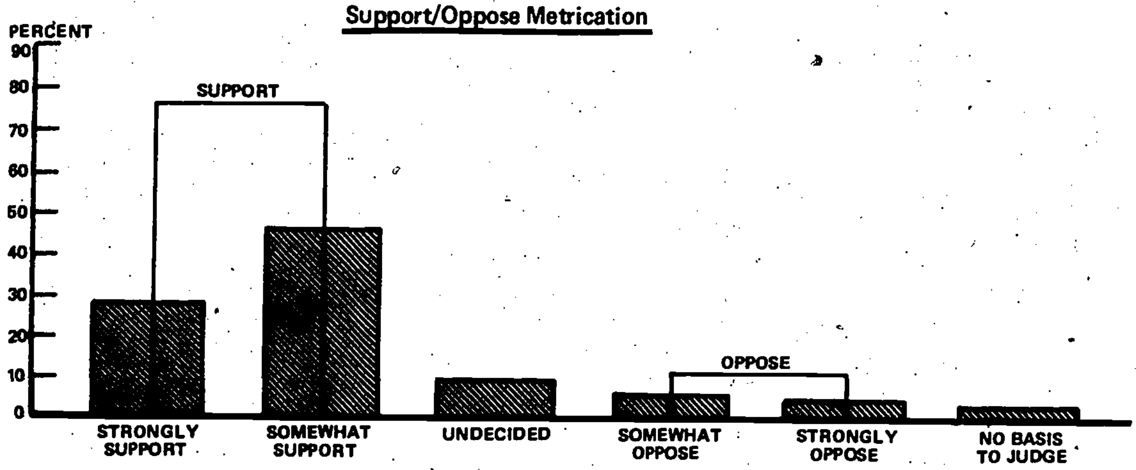
classifications, a more thorough analysis was undertaken; these are discussed more fully in their respective chapters.

Position on metric conversion

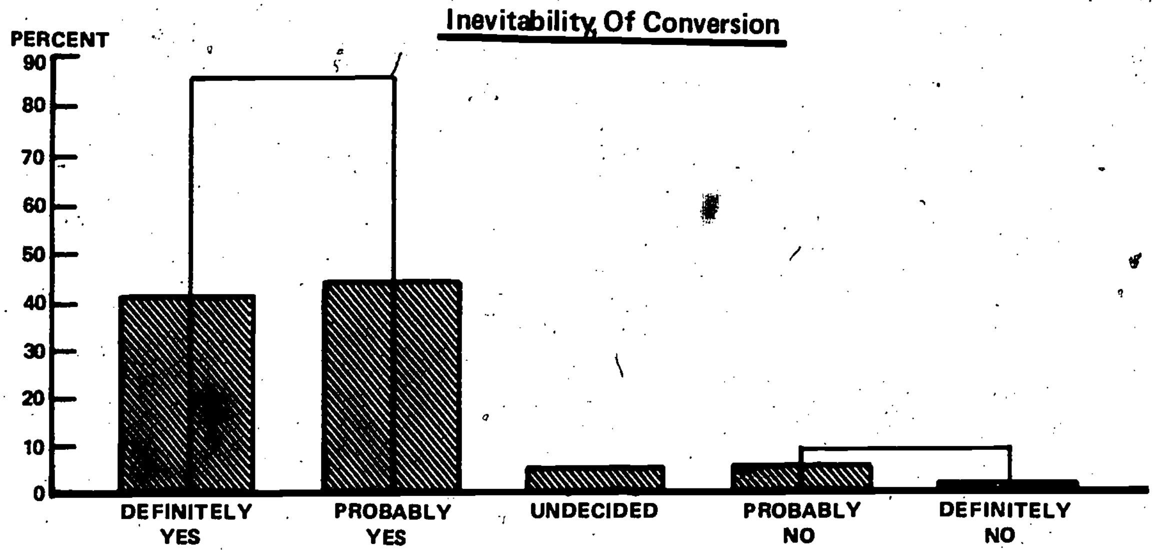
Most Fortune 500 companies are aware that the national policy is presently one of Federal coordinating and planning of voluntary conversion. However, 53 companies thought the national policy was to have a mandatory conversion to the metric system.

Most of the companies (76 percent) support U.S. conversion to the metric system. However, as shown by the following graph, the majority of those who support conversion support it somewhat.

Support/Oppose Metrication



The largest companies in each industry usually support conversion. Most of the companies (86 percent) believe that conversion is inevitable; less than 9 percent feel that it is not. The majority of companies in all industries viewed metrication as being inevitable for their respective industries.



If the perceptions of the Fortune 500 companies are correct, metrication will at some time take place--be inevitable. Additional work was done in three selected industries--petroleum, aerospace, and food--to determine why they believed metrication was inevitable. (See chs. 14, 15, and 27 respectively.)

There is a strong relationship between a company's feeling that conversion is inevitable and its support for conversion. Of the 174 companies that stated conversion is definitely inevitable for their business, 96 percent support conversion for the United States; the remainder were either undecided or had no basis to judge. On the other hand, the majority of those who believe conversion is definitely not inevitable oppose it.

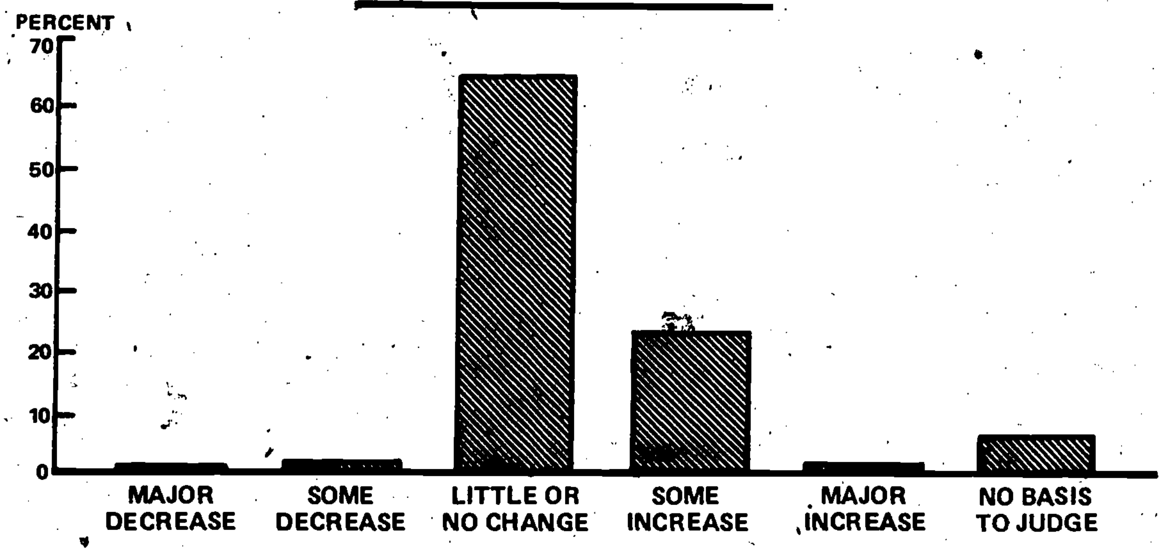
Even though the majority of companies view metrication as inevitable for their industry and are supportive of U.S. conversion, only 10 percent responding view themselves as leaders. Instead, most companies (55 percent) either view themselves as meeting the demands of customers or as following the lead of others (26 percent).

Eight percent of the companies either believed they were unaffected by metrication or had some other view of themselves. Only 1 percent of the companies are attempting to block or postpone metrication. These companies are not concentrated in any one industry.

The motor vehicles and industrial and farm equipment industries are two industries in which the majority of larger companies (the top 20 percent) consider themselves leaders in metrication. Collectively, the Fortune 500 companies, in their estimation, are not "leaders" in metrication; rather, only a small portion are taking the lead.

Most companies see little or no change in the prices of their products as shown in the following chart. Some did feel that conversion would cause an increase in their prices. Very few felt that there would be any decrease.

Impact Of Metrication On Prices



Status of metrication in business

About half of the companies are involved to some degree in the following conversion activities. About half have no plans. The following table shows the status for each of the polled activities.

Status of Metrication

Activity	Status (note a) No plans for	Plans for	In progress	Completed
	----------	(percent)	----------	
Coordination with industry	30	17	42	4
Metric coordinator or committee	35	7	14	42
Metric policy statement	42	14	9	29
Employee training	47	24	23	2
Coordination with Government	49	15	20	1
Cost analysis	50	15	17	11
Supplier surveys	53	13	17	9
Consumer information	54	11	16	2
Customer surveys	59	9	12	9
Timetable for conversion	61	13	12	6
Funds budgeted for conversion activity	66	10	9	4

a/Will not add to 100 percent because a number of respondents indicated the activity did not apply or they had no basis to judge.

Companies involved beyond the planning stage in any of the above activities are usually supportive of conversion and feel that it is definitely inevitable. Companies that are less supportive or less sure that conversion is inevitable usually have no plans for conversion activities.

Advantages and disadvantages

The companies were asked the extent to which metrics were used in engineering drawings. Most companies (75 percent) use the customary units for products manufactured in the United States. Eleven percent use dual dimensions on their drawings, and 2 percent use separate customary and metric drawings. Only 2 percent use metric-only drawings. Ten percent of the companies responded that this question did not apply.

For products manufactured abroad, 33 percent use metric units only in their engineering drawings, 19 percent use customary units only, and 16 percent use dual dimensions. Twenty-eight percent of the companies responded that this did not apply.

The companies were asked whether they thought that each of a number of often cited advantages of conversion was an advantage for their business. The following table shows the respondents' views.

Frequently Attributed Advantages (note a)

Advantage	Agree	Disagree	Does not apply	No basis to judge
	(percent)			
Conversion will provide an opportunity to standardize products	61	18	16	5
Trade will be facilitated through a common measurement language	59	19	10	12
The metric system is easier to use and would result in fewer errors	55	28	4	13
Conversion will provide an opportunity for improving product standards	36	43	11	10
Conversion will increase or protect the present amount of exports and work overseas	27	32	23	18
Use of the metric system will increase production efficiencies	20	54	11	15
Use of the metric system will facilitate technological advances	13	57	14	16
Conversion will stimulate your industry	7	66	12	16

a/May not add to 100 percent because of rounding.

A summary of how each advantage was perceived by each industry is contained in appendix VII.

The companies were also asked whether they thought that each of a number of often cited disadvantages of conversion was a disadvantage for their business. The following table shows their views.

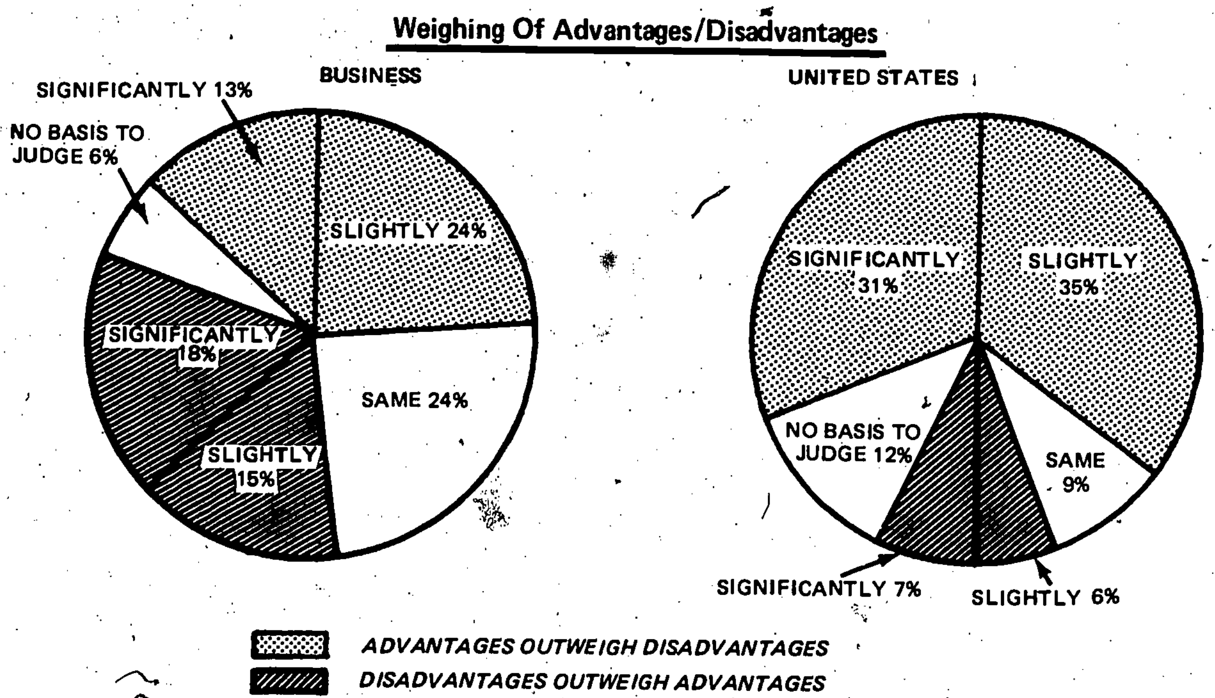
Frequently Attributed Disadvantages (note a)

Disadvantages	Agree	Disagree	Does not apply	No basis to judge
	------	------	(percent)	------
Conversion will result in dual inventories	68	23	4	5
Conversion will be costly	67	26	2	5
Training employees will be time consuming	65	31	2	3
Product standards will have to be changed	60	27	6	7
Customers will be confused by the metric system	52	36	4	8
Conversion will increase the prices of products	31	50	4	15
Conversion of products will require retesting	25	57	9	9
Conversion will result in safety hazards and errors	13	68	5	14
Sales will be lost to foreign imports	6	76	7	12

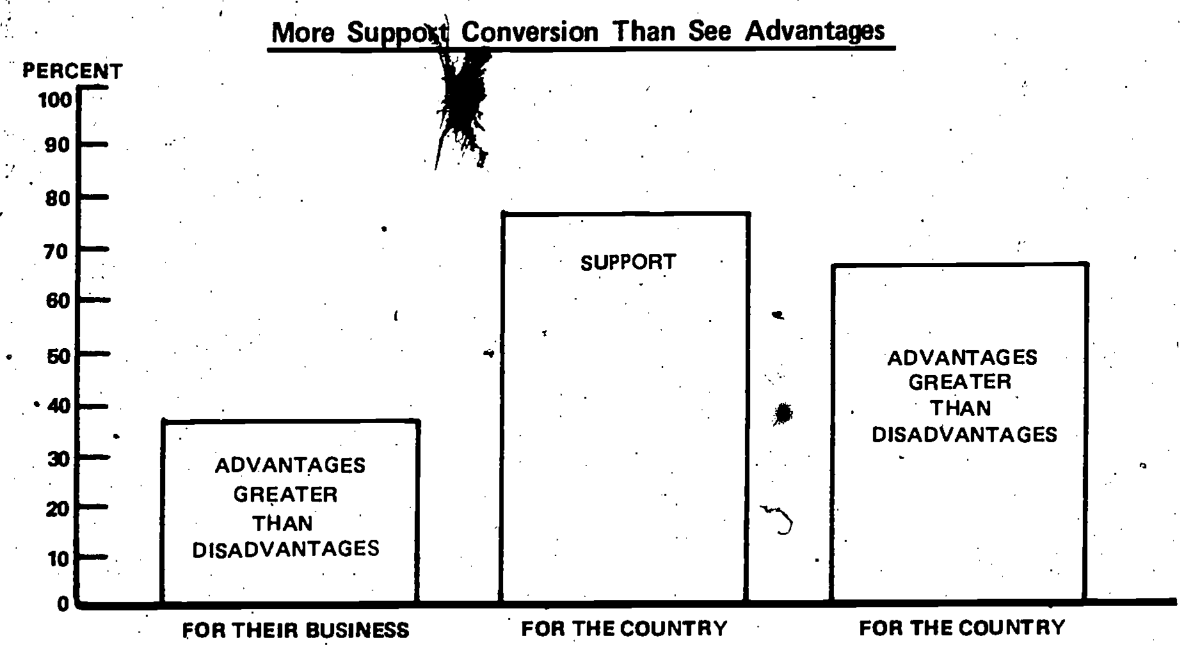
a/May not add to 100 percent because of rounding.

A summary of how each disadvantage was perceived by each industry is contained in appendix VIII.

Many of the Fortune 500 companies evidently believe that someone other than themselves will benefit from conversion. Only 37 percent felt that conversion would be an advantage to their businesses; however, 66 percent felt that it would be advantageous for the Nation overall.

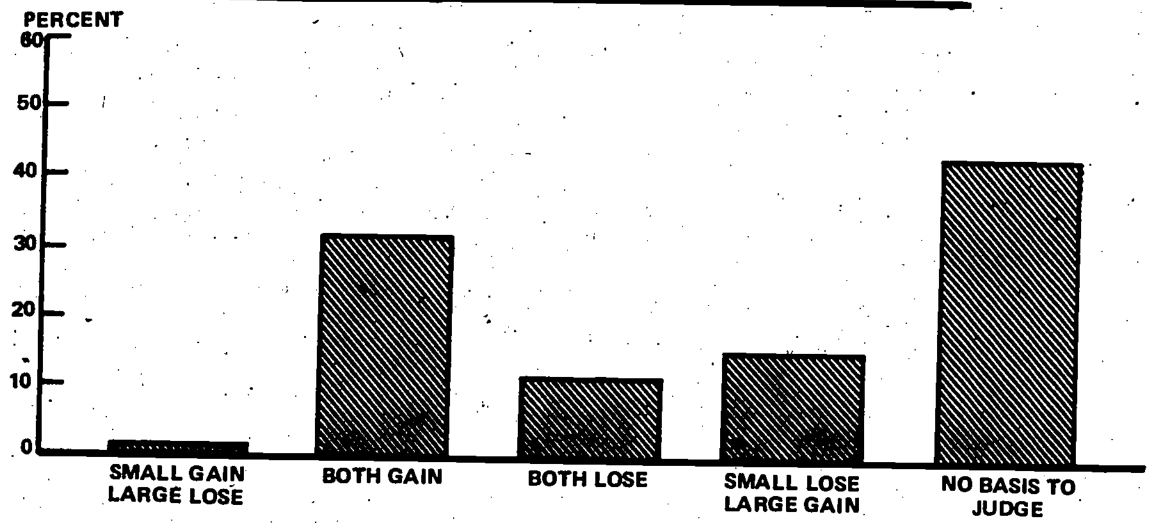


The Fortune 500 companies' support for conversion is only partially based on their perception of the advantages of conversion. As the following chart shows, more companies supported conversion than believed its advantages outweighed the disadvantages for their businesses or the country.



When asked if large and small firms would gain or lose from metric conversion, 43 percent of the companies felt they had no basis to judge. Of those that did make a judgment, a slight majority felt that both large and small firms would gain. However, of those that felt that someone would lose, more felt that small firms would lose.

Will Large Or Small Business Gain Or Lose From Conversion?



The companies were asked to give their opinions on the impact of metric conversion on U.S. exports and imports. These views are presented in chapter 4.

The role of Government

Forty-one percent of the Fortune 500 companies felt that no laws or regulations currently inhibit conversion to the metric system. The most often cited laws or regulations are listed in the table below.

Inhibiting Laws and Regulations

Law or regulation	Percent
State and local laws	17
Building codes	15
Other Federal laws	14
Federal antitrust laws	12
Federal or State procurement regulations	10
Other	7

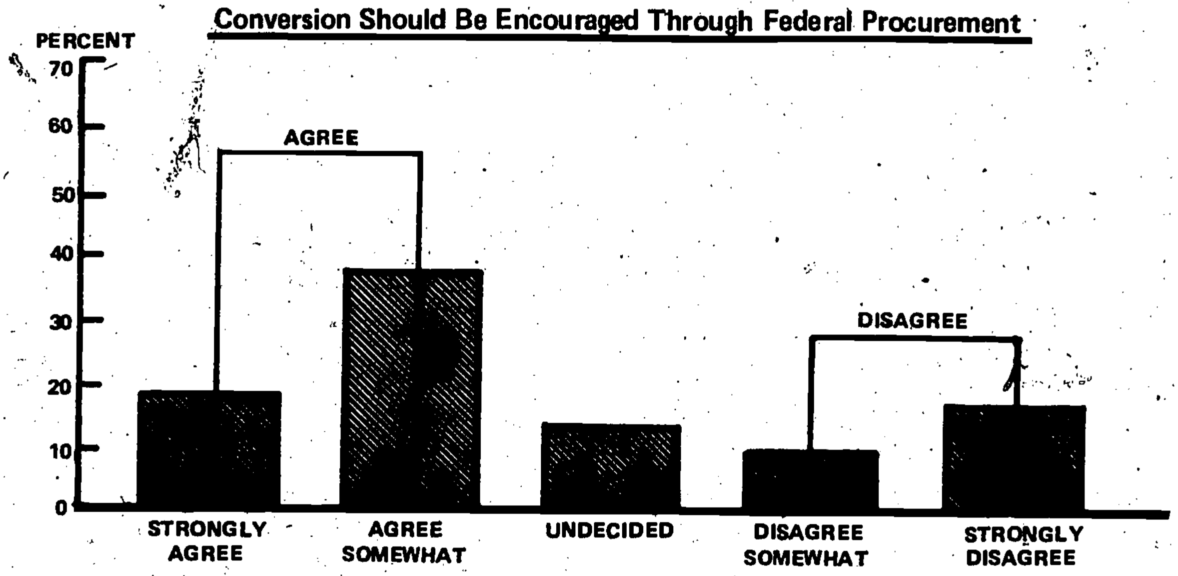
If metric conversion occurs, the role of the Federal Government as viewed by the companies would generally be to provide assistance in coordinating activities, counseling and advising interested parties, and/or establishing target dates.

Role of the Federal Government

Role	Percent
Coordinate activities	53
Counsel and advise interested parties	52
Establish target dates	46
Plan the overall conversion	20
Make conversion mandatory	14
Legislate the conversion process	9
Other	8
Enforce the conversion process	5
None of the above	6

Even though most companies feel that the Federal Government should not make metric conversion mandatory, they do feel that it should encourage conversion by purchasing items designed or described in metric terms. There was some strong disagreement with this opinion as shown below; however, those who support conversion generally agree.

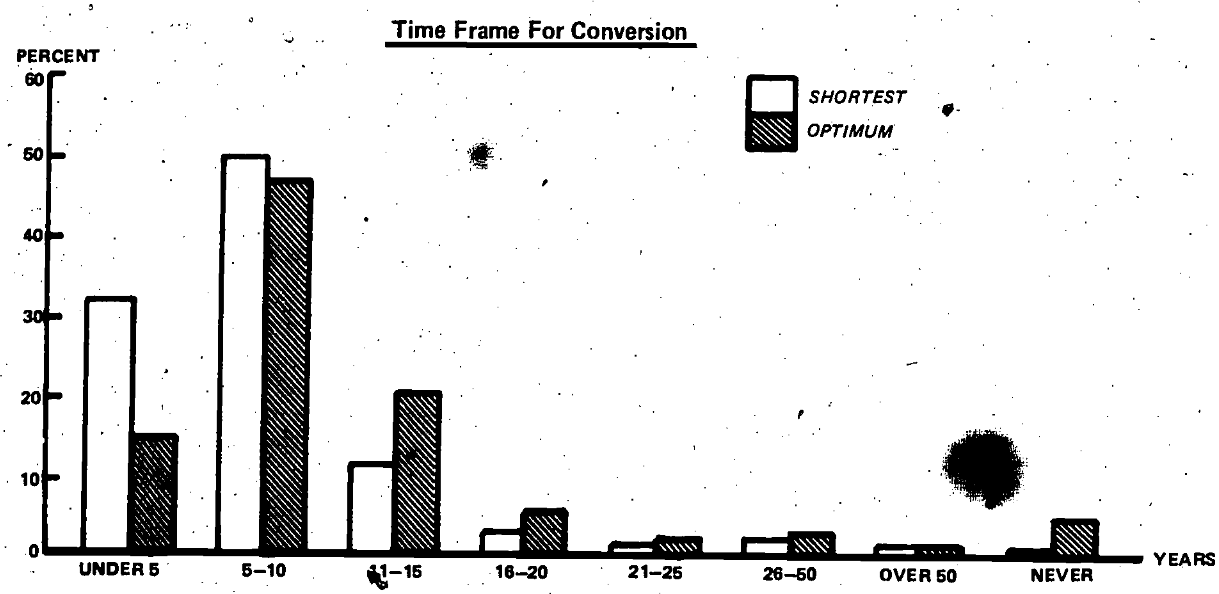
Conversion Should Be Encouraged Through Federal Procurement



Time frame for conversion

The following chart shows the respondents' views on the shortest (if mandatory) time frame and the optimum time frame in which they could convert.

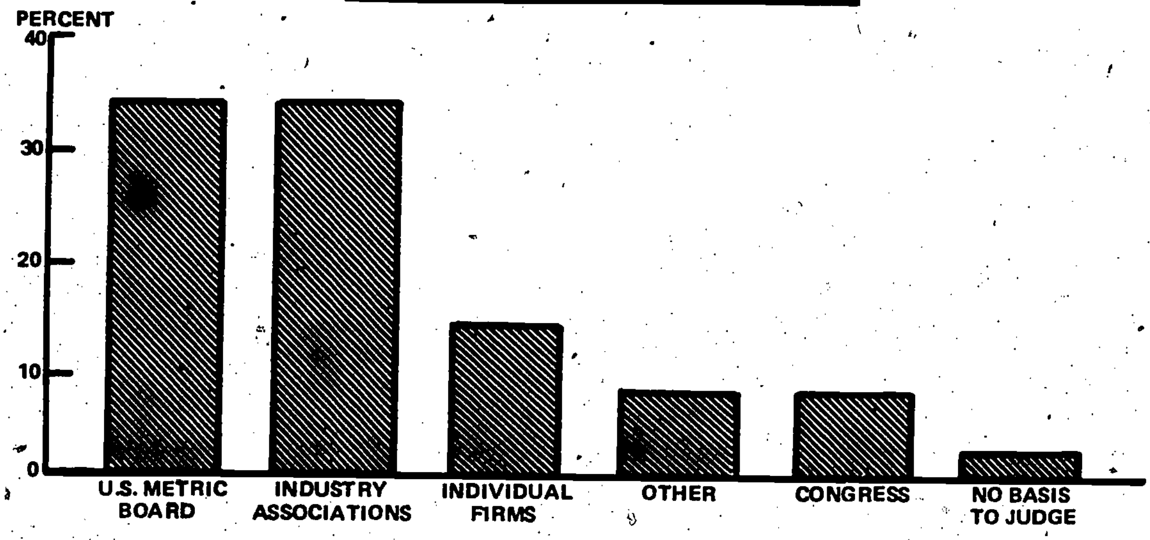
Fifty percent of the companies felt that a 5- to 10-year conversion period would be the shortest time frame in which they could convert if conversion were mandatory. Nearly 32 percent felt that less than 5 years would be sufficient. Combined then, 82 percent felt that a time frame not in excess of 10 years would be adequate.



When asked what the optimum time frame would be, the 5- to 10-year time frame was again the most popular (47 percent). Nearly 15 percent felt they needed less than 5 years. The two periods combined--within 10 years--would allow for 62 percent of the companies to convert in an optimum time frame. Approximately the same percentage can convert in an optimum period of 15 years or less (83 percent) as can convert in a mandatory period of 10 years or less (82 percent).

If the United States should convert to the metric system on a planned basis, someone would have to establish the date by which each industry would convert. The Fortune 500 companies were evenly split between having the U.S. Metric Board (in consultation with industry) and the industry associations establish the conversion dates. The next most popular option was to have individual firms establish the dates. The least popular was to have the Congress do it.

Who Should Establish Conversion Dates?



SMALL BUSINESS

In addition to the Fortune 500, we also surveyed 1,400 small businesses selected from the membership listing of a small business association and a listing of small businesses from a commercial firm.

Responses were received from firms classifying themselves as manufacturers; retailers; wholesalers; services; professionals; miners; and in the areas of agriculture, transportation, construction, and finance. Responses (about 5 percent) were also received from businesses that did not consider themselves in any of these classifications.

The largest number of the firms fell in the $1-million to $5-million gross sales range and had between 5 and 24 employees. (See app. IV for detail on respondents.)

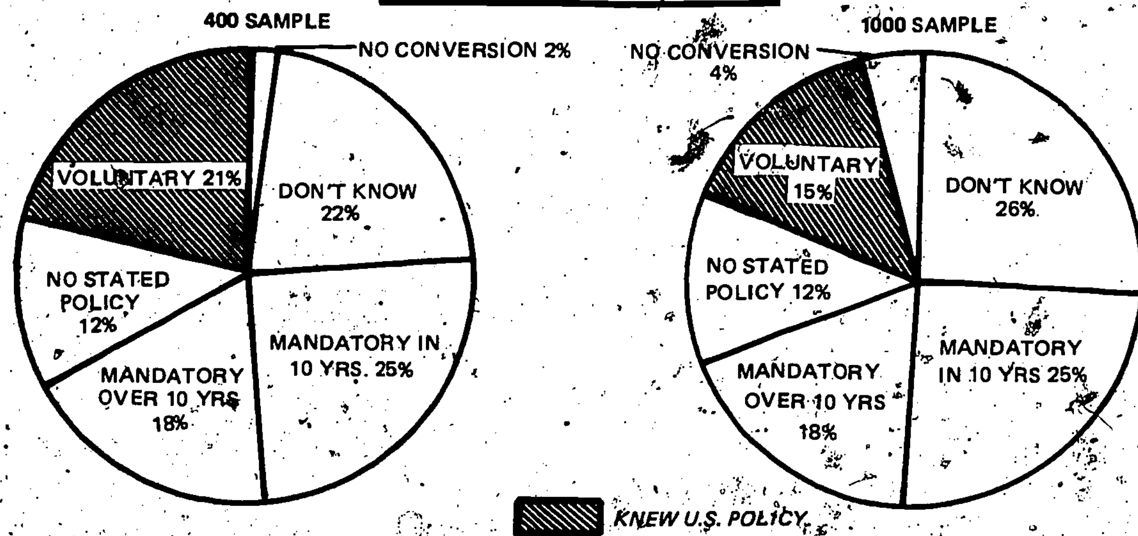
The businesses responding to our questionnaire may or may not be representative of the kinds and sizes of small businesses throughout the United States. In fact, we question the existence of a universally accepted definition of small business. Hence, we did not attempt to project the results of our survey to all small businesses. What follows are the results of a polling of 1,000 small businesses and 400 members of a small business association.

Position on metric conversion

National policy

Few of the respondents knew the U.S. policy on metric conversion. As the following chart shows, almost half of the respondents believed conversion to be mandatory.

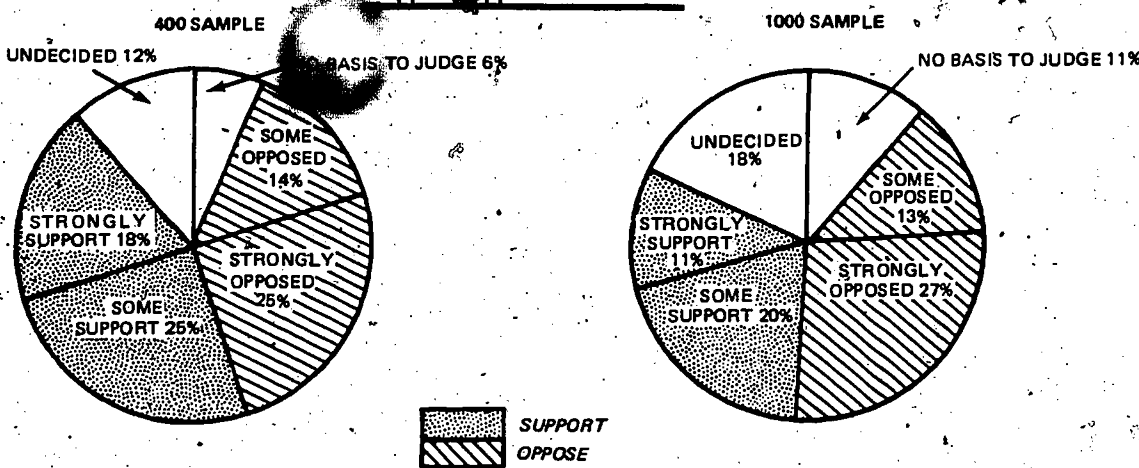
Understanding Of Metric Policy



Support or opposition

Small businesses responding were divided in their support or opposition to metric conversion. However, most of those who opposed conversion strongly opposed it while most of those who supported it, supported it only somewhat. A considerable number indicated they were undecided on the question.

Support/Oppose Mertication

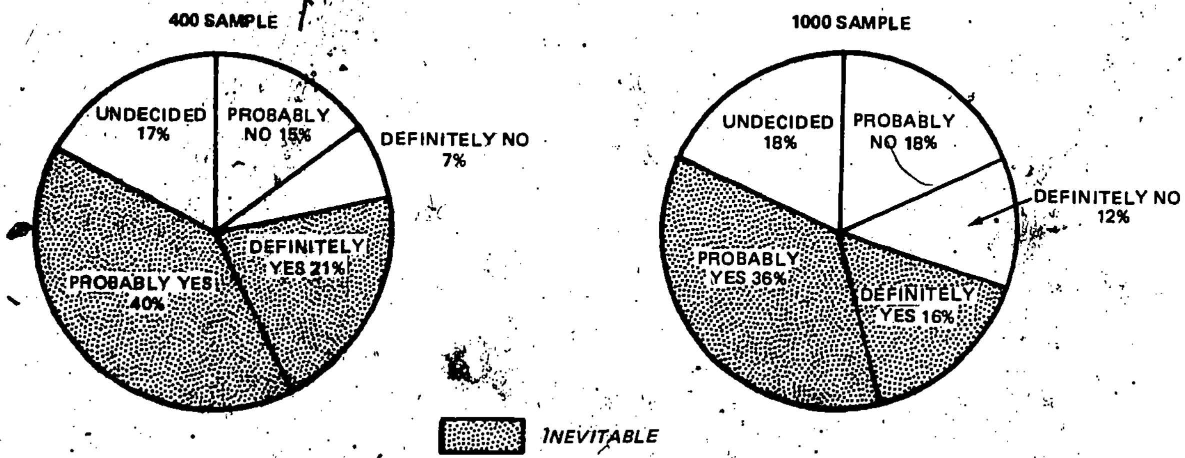


The responses to the sample of 1,000 businesses indicated that a considerable number of respondents were undecided on their support or opposition to conversion or that they had no basis to judge. Of those who took a position, respondents in retail, agriculture, and finance opposed conversion by about a 2 to 1 ratio. Wholesalers were almost evenly divided, while manufacturers tended to support conversion. Those in services, transportation, and construction tended to oppose it.

Inevitability

A majority of the respondents believed that metric conversion is inevitable or probably inevitable for their businesses.

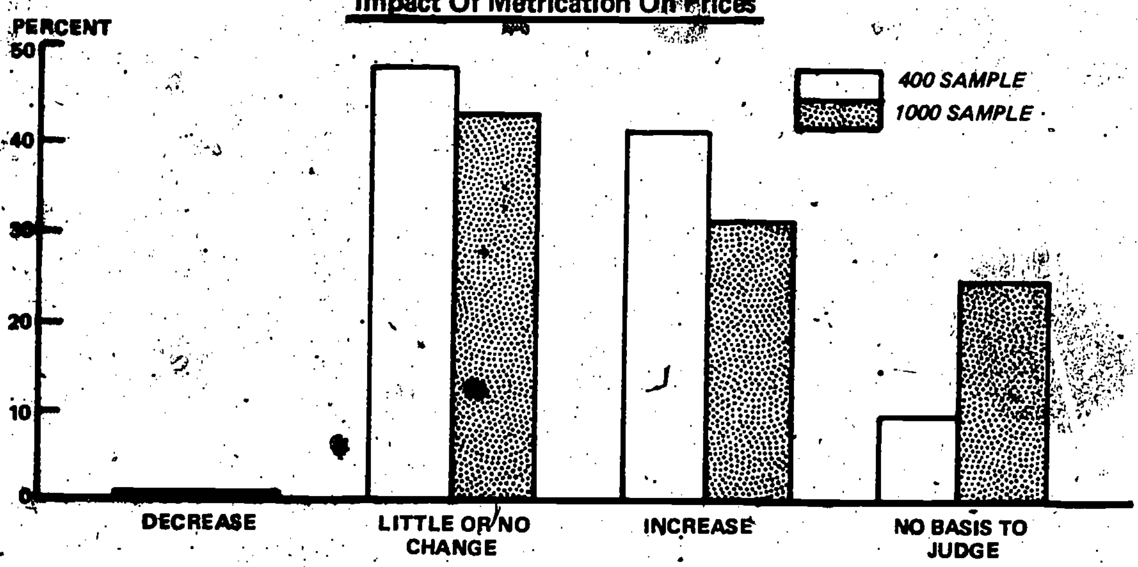
Is Conversion Inevitable?



Price change

The largest segment of respondents believed that metric conversion would result in little or no price changes in their products. A considerable number, however, thought there would be an increase, although most believed it would not be major.

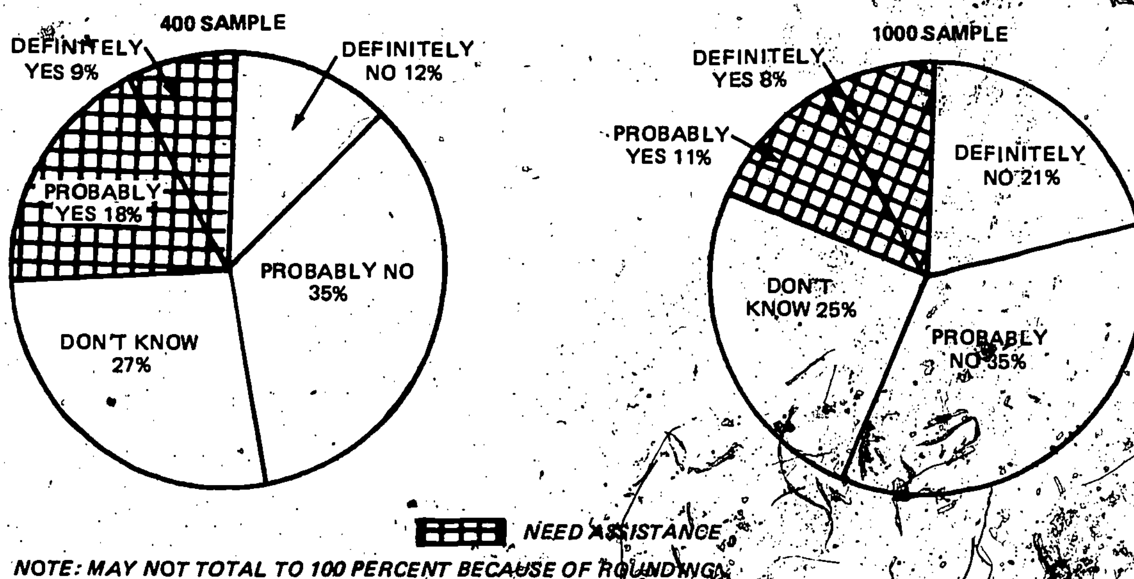
Impact Of Metrication On Prices



Financial assistance

Considerable speculation exists over whether small business will need assistance to finance conversion to the metric system.

Respondents' Views On Need For Financial Assistance

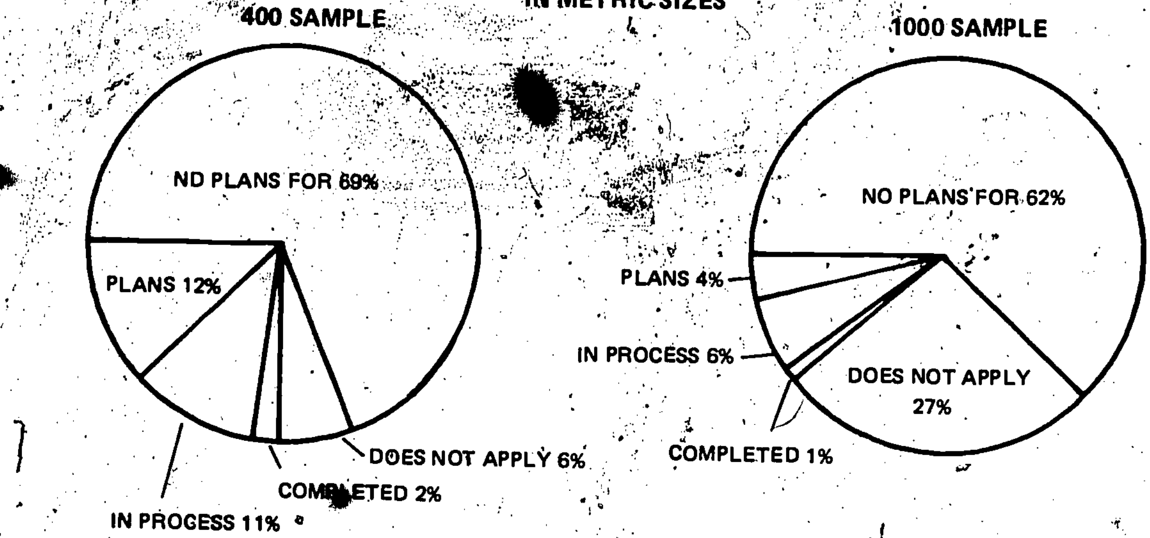


Status of metrication

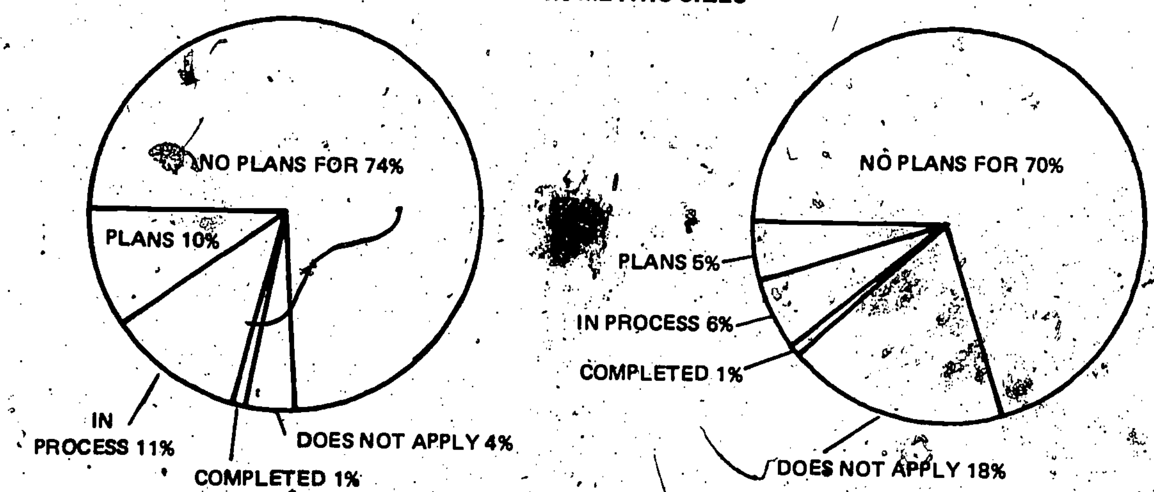
Although a majority of the respondents believe conversion is inevitable or probably inevitable for their businesses, the following charts show they have taken little positive action for the activities cited.

Status Of Metrication

CONVERT OR DEVELOP PRODUCTS
IN METRIC SIZES



CONVERT OR OBTAIN EQUIPMENT
IN METRIC SIZES



Advantages and disadvantages

The businesses were asked whether they agreed or disagreed that each of a number of often cited advantages of conversion was an advantage for their businesses.

Respondents Opinions on Often Cited Advantages (note a)

Advantages	Agree		Disagree		Does not apply		No basis to judge	
(Sample)	400	1,000	400	1,000	400	1,000	400	1,000
	(percent)							
The metric system is easier to use and would result in fewer errors	34	28	43	40	6	9	17	23
Conversion will increase or protect the amount of exports and/or work overseas	27	22	25	22	20	20	29	36
Conversion will provide an opportunity to standardize products	41	39	31	27	14	13	14	21
Use of the metric system will increase production efficiencies	10	10	56	41	10	14	24	34
Conversion will stimulate business	11	8	56	49	11	13	22	31
Use of the metric system will facilitate technological advances	17	14	46	37	11	11	[illegible]	[illegible]

a/May not total to 100 percent because of rounding.

The businesses were also asked whether they agreed or disagreed that each of a number of cited disadvantages of conversion was a disadvantage for their businesses.

Respondents Opinions on Often Cited Disadvantages (note a)

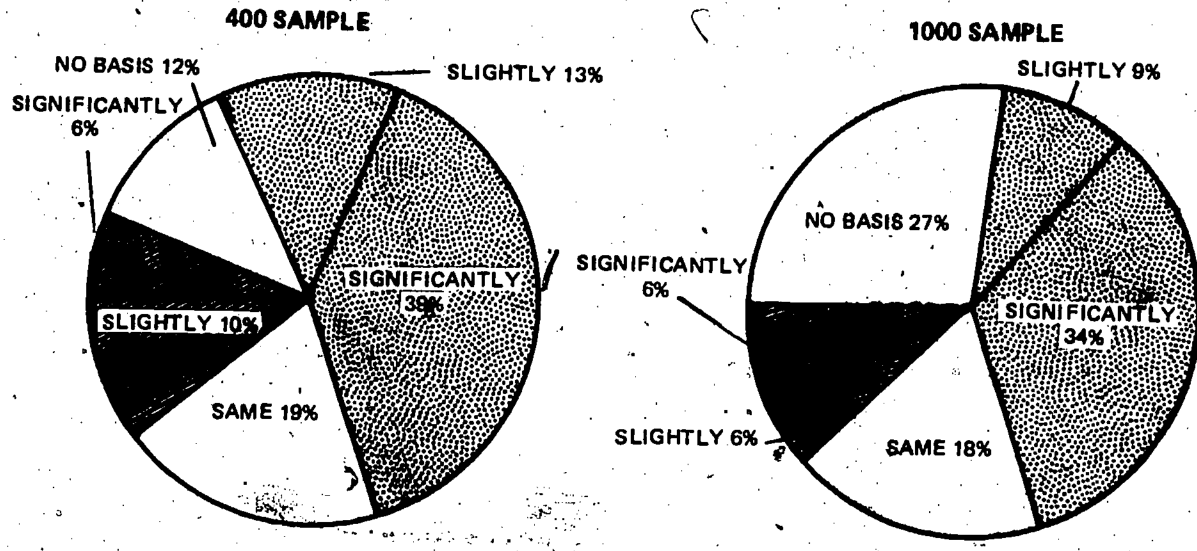
Disadvantages	Agree		Disagree		Does not apply		No basis to judge	
(Sample)	400	1,000	400	1,000	400	1,000	400	1,000
	(percent)							
Conversion will be costly	73	64	13	9	2	9	12	17
Training employees will be time consuming	79	69	14	12	2	9	5	10
Conversion will result in dual inventories	56	52	21	18	12	16	11	14
Customers will be confused by the metric system	67	68	18	10	3	9	12	13
Conversion will increase the price of your business products and/or services	52	40	24	24	5	11	19	25
Conversion will result in safety hazards and errors	25	25	45	34	7	14	22	27
Sales will be lost to foreign imports	6	7	50	41	21	22	23	30
Codes and standards will have to be changed	81	69	6	7	4	8	9	16

a/May not total to 100 percent because of rounding.

The respondents were asked to weigh the overall advantages and disadvantages of conversion for their businesses and also for the country. They expressed a generally negative opinion on the advantages of conversion for their businesses, but expressed a more positive opinion on the advantages of conversion for the country. Evidently, they believed someone other than themselves would benefit. The respondents' views are shown on the following charts.

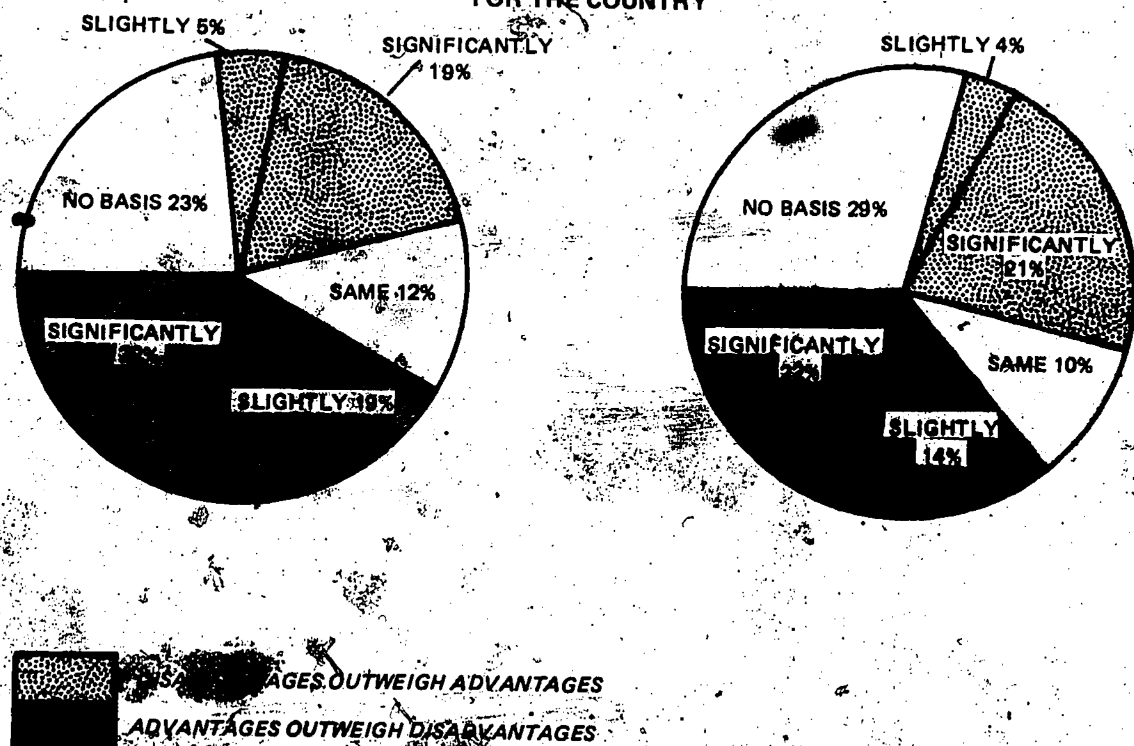
Will Advantages Outweigh Disadvantages?

FOR THE BUSINESS

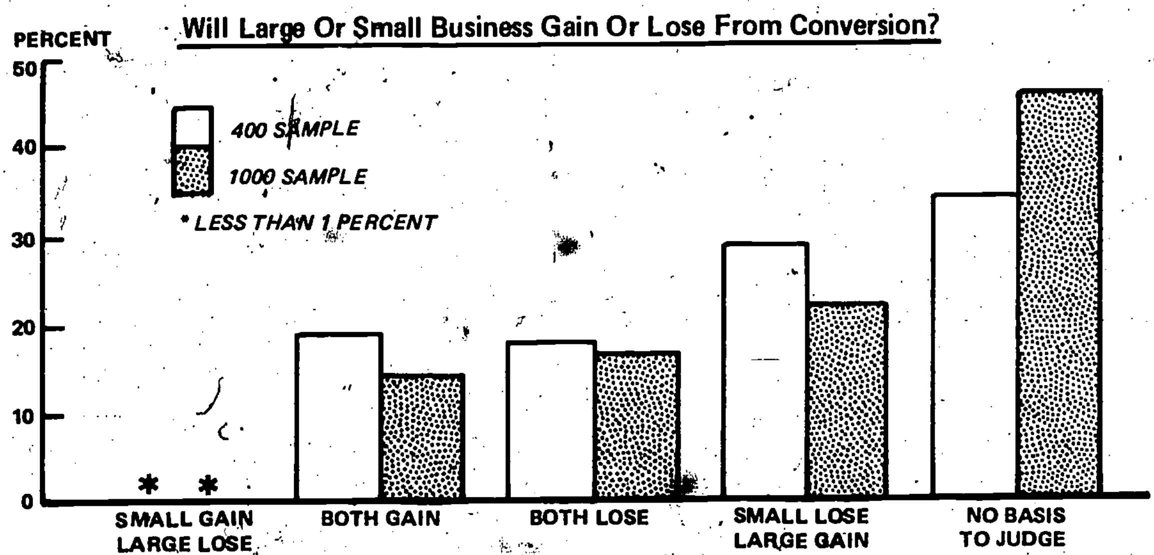


NOTE: MAY NOT TOTAL TO 100 PERCENT BECAUSE OF ROUNDING

FOR THE COUNTRY



The largest percentage of respondents indicated that they had no basis to judge whether small or large business would gain or lose from metric conversion. As the following chart shows, however, a substantial number of the respondents perceived that large business would gain while small business would lose.



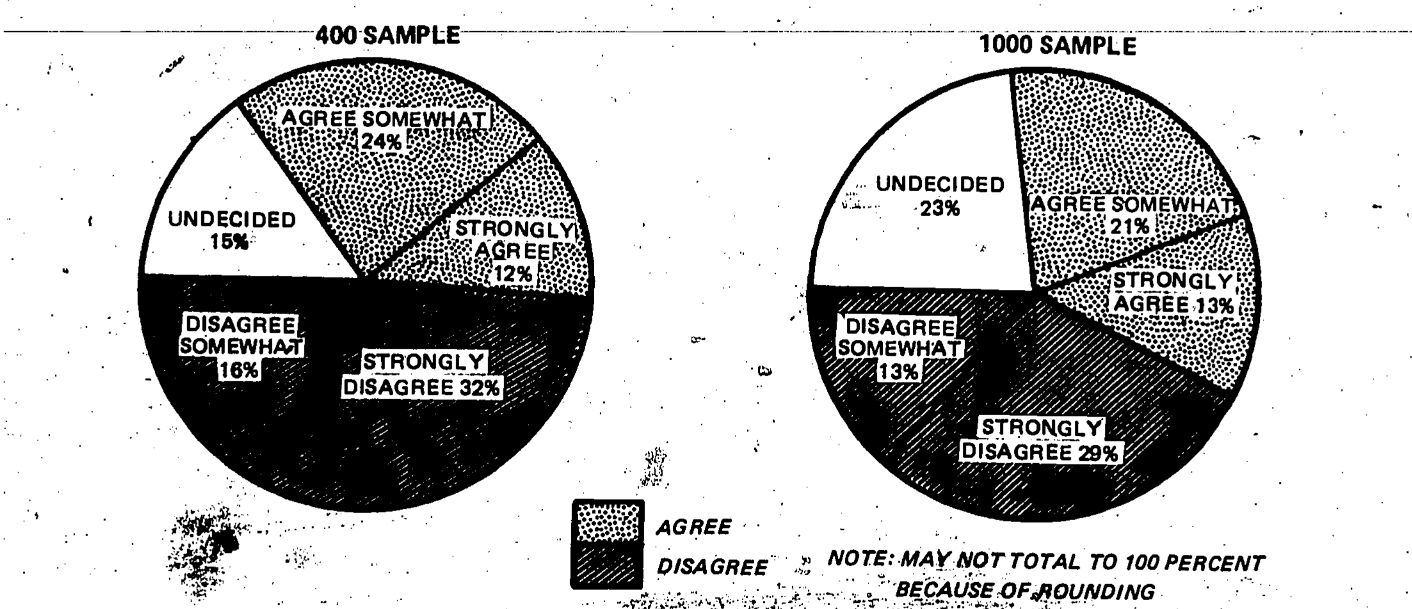
Role of Government

Generally, the respondents believed the Federal Government's role in metrication should be that of counseling, advising, planning, and establishing target dates for conversion. Few believed the Government should legislate or enforce conversion.

The businesses were asked what laws or regulations currently make it difficult for them to convert to the metric system. The vast majority of the respondents either did not know or did not believe any laws or regulations would make conversion difficult. Those who did cite some laws or regulations most frequently identified building codes, State and local laws, and Federal laws.

More of the respondents disagreed than agreed that the Government should encourage metric conversion by purchasing items designed or described in metric terms.

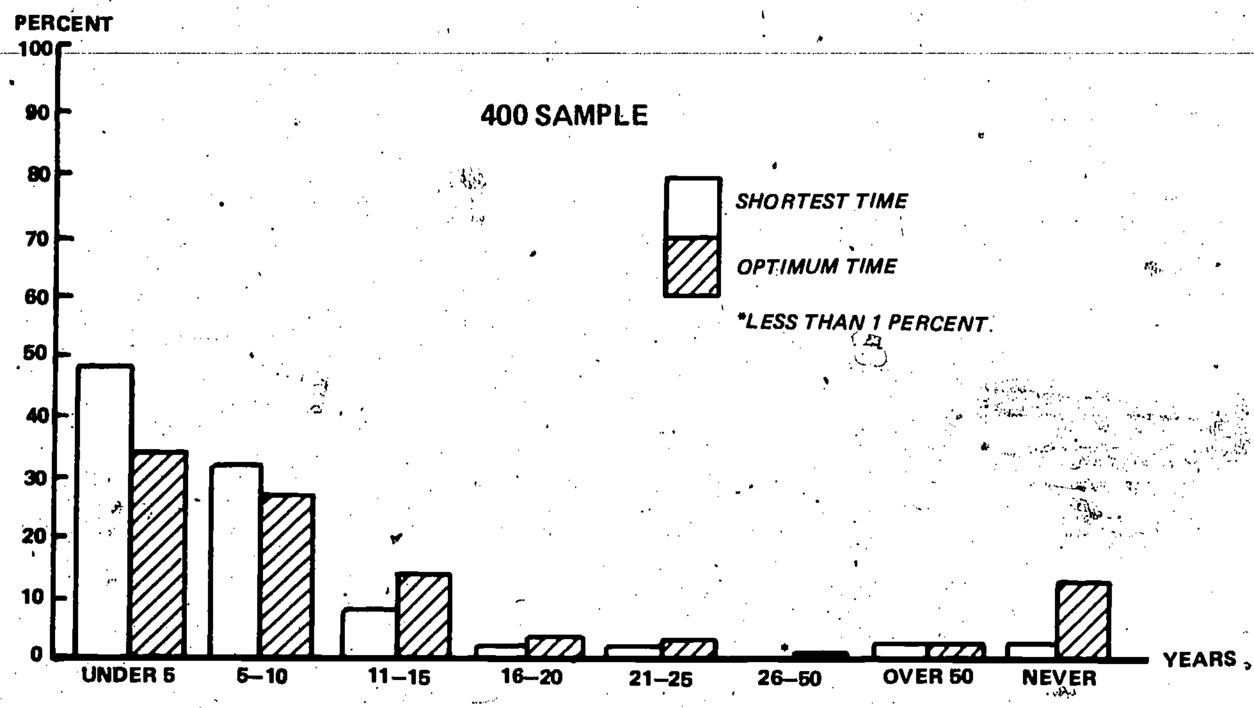
Conversion Should Be Encouraged Through Federal Procurement

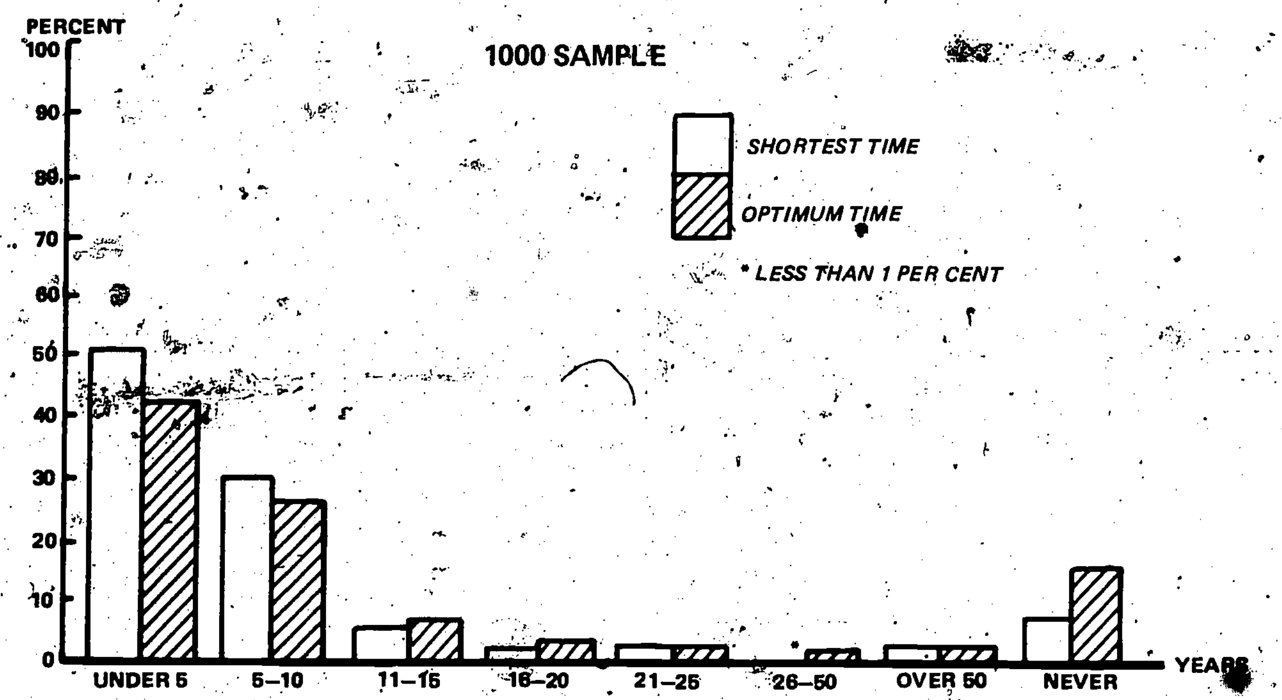


Time frame for conversion

As the following charts show, about 90 percent of the respondents believed they could convert within 15 years under a shortest time frame concept. If conversion were not mandatory and made in the optimum time frame rather than the shortest time frame, the percentage that could convert within the 15-year period would decrease to 77 percent. Also, in the nonmandatory optimum time frame situation, the number of respondents indicating they would never convert increased.

Shortest And Optimum Time Frame For Conversion





The respondents believed industry and industry associations should play a role in establishing conversion dates. The following table shows their views on who should establish the dates.

Who Should Establish Conversion Dates

	Sample of 400	Sample of 1,000
	---(percent)---	
The Congress	9	16
U.S. Metric Board in consultation with the industry	37	33
Industry associations	28	21
Individual firms	18	11
Other	1	2
No basis to judge	7	17

Views of small business associations

Discussions with several associations indicated that the question of metrication was not a pressing issue with the associations or their membership.

An official of the National Federation of Independent Businesses noted that small business is not a unified community but rather a community of varied segments; therefore, the reactions of one segment toward metrication might be quite different from the views of another. However, he said that small business has generally given little thought to metrication. Small businesses basically reflect the views of their customers. In this regard he noted that for the small manufacturer which is the supplier for a large corporation, metrication might not be a matter of choice. If that large corporation converts to metrics, metrication may be a necessity for the small manufacturer.

The association would oppose any Federal law or regulation that would require Government procurement to be in metric specifications because small business could be seriously affected. The association would favor the availability of Federal loans for metrication activity.

The official noted further that only a small proportion of the small businesses are involved in foreign trade; consequently, they may have difficulty in relating to the argument that conversion by the United States would assist its trade position.

An official of the National Small Business Association also believed that small business, and for that matter, all business had little awareness of what is going on in metrication. In his opinion the inroads metrication has made in business are in the large corporations. He did believe, however, that small business would benefit from conversion to the metric system through simplifying computations in the manufacturing process and through standardization. He also favored some form of Federal loans to small business to help them cope with conversion.

Views of the Small Business Administration

An official of the Small Business Administration also believed small business has little awareness of metrication. He believed that small business does not have the time or the resources to plan for metric conversion, particularly when conversion is not immediate. As metrication increases in the United States, he believes small business will, through necessity, become more concerned and will need financial and managerial assistance to acccomplish the conversion.

Currently, the Small Business Administration has no special programs to provide assistance to small business--either financial or managerial--for metric conversion. However, the Small Business Administration official said, small businesses can obtain financial assistance for metric conversion under existing Small Business programs if they are otherwise qualified. He did not know whether any firms have applied for such assistance. Thus far, technical assistance has been limited to the preparation and distribution of a booklet on metric conversion.

The Small Business Administration is also attempting to develop an automated listing of small businesses and their capabilities, including any metric capability.

CONCLUSIONS

Most of the small business respondents did not know the U.S. policy on metric conversion; most large business respondents did know. Over 40 percent of the small businesses and 13 percent of the large businesses believed incorrectly that conversion is mandatory.

The largest percentage of the respondents, both large and small, saw little or no price changes in their products as a result of metric conversion. A considerable number did see some price increase, however.

Most of the respondents believed that the Federal role in conversion should be that of coordinator, planner, and counselor, rather than enforcer. The large business respondents believed the Government should encourage conversion through purchase of metric goods. Of the small business respondents expressing an opinion, most opposed this position.

Most of the respondents believed they could convert to the metric system within 10 years; a considerable number indicated they could convert in less than 5 years. An overall time frame of 15 years would allow about 80 percent of the firms we questioned to convert within an optional period of time. Most respondents also believed that the industry should be involved in establishing target dates for conversion.

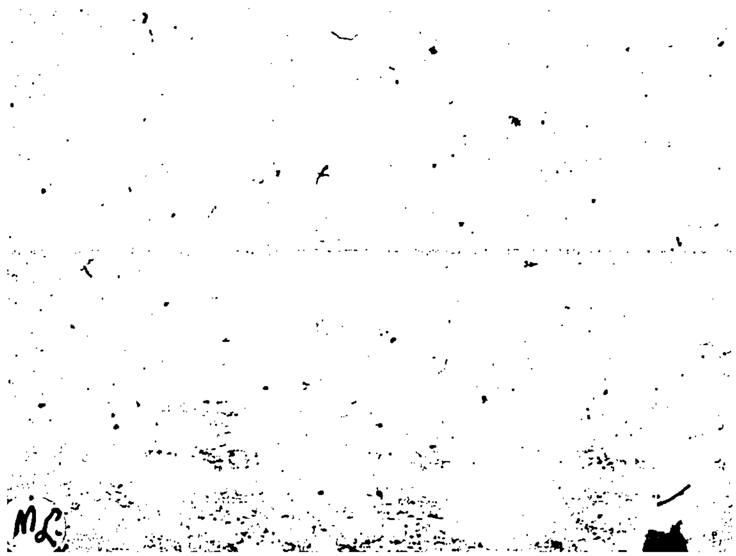
More of the small business respondents believed they would not need assistance to finance metric conversion than believed they would. However, a considerable number did not know.

Few respondents indicated little conversion activity beyond planning and coordinating.

The large business respondents generally supported conversion to the metric system while the small business respondents were divided in their support or opposition; both believed conversion to be inevitable.

In both cases, more of the respondents supported conversion than perceived the advantages as outweighing the disadvantages of conversion for their business. The large business respondents were divided over the relative advantages and disadvantages of conversion, and more of the small business respondents believed conversion to be disadvantageous than advantageous. However, when considering the relative advantages and disadvantages of conversion for the United States overall, both groups shifted to a more positive opinion of the advantages. A majority of the large business respondents now believed the advantages to be greater than the disadvantages, and more of the small business respondents believed conversion would be advantageous than disadvantageous.

Thus, it seems that the respondents believed that someone other than themselves would gain the advantages of metrication.



U.S. GENERAL ACCOUNTING OFFICE

METRIC TASK FORCE

SURVEY OF LARGE CORPORATIONS

INSTRUCTIONS:

Please answer each of the following questions as frankly and completely as possible for the product line representing the greatest volume of sales for your company. We are interested in your company's views whether or not your company is active in the area of metric conversion.

We have made the following assumptions so that all respondents will have a common basis for answering:

- Conversion means physical changes, not just substituting metric measurement units for English or customary measurement units (i.e., inch, pound, quart, etc.).
- Conversion does not apply to items already produced or in production.
- During the conversion, metric supplies and services will be readily available.

There is space at the end of the questionnaire for any comments you may wish to make concerning these assumptions, the questionnaire, or any other related topics.

The questionnaire is numbered only to permit us to delete your company's name from our list when we receive your completed questionnaire and thus avoid sending you an unnecessary followup request.

Throughout the questionnaire there are numbers printed within parentheses to assit our keypunchers in coding responses for computer analysis. Please disregard these numbers.

RESPONDENT INFORMATION:

NAME: ____________________

TITLE: ____________________

TELEPHONE: (   ) ____________________
(Area code) (Number)

A. National Policy

1. What is your company's understanding of the national policy concerning converting to the metric system? (Please check one.) (6)

1 ☐ No stated national policy
2 ☐ Mandatory conversion within 10 years
3 ☐ Federal coordinating and planning of voluntary conversion
4 ☐ Mandatory gradual conversion (i.e., more than 10 years)
5 ☐ No conversion
6 ☐ Don't know
7 ☐ Other (Please specify) ____________________

2. Does your company support or oppose the United States converting to the metric system? (Please check one.) (7)

1 ☐ Strongly support
2 ☐ Somewhat support
3 ☐ Undecided
4 ☐ Somewhat oppose
5 ☐ Strongly oppose
6 ☐ No basis to judge

APPENDIX I

3. Does your company believe that conversion to the metric system is inevitable for your industry? (Please check one.) (8)

 1 [ ] Definitely yes
 2 [ ] Probably yes
 3 [ ] Undecided
 4 [ ] Probably no
 5 [ ] Definitely no

4. Which of the following laws or regulations, if any, currently inhibit conversion by your company to the metric system? (Please check all that apply.)

 1 [ ] Federal antitrust laws (9)
 2 [ ] Other Federal laws (10)
 3 [ ] State and local laws (11)
 4 [ ] Building codes (12)
 5 [ ] Federal or State procurement regulations (13)
 6 [ ] Other (Please specify)________ (14)
 7 [ ] None (15)
 8 [ ] No basis to judge (16)

5. If metric conversion occurs, which of the following roles, if any, should the Federal Government assume? (Please check all that apply.)

 1 [ ] Plan the overall conversion (17)
 2 [ ] Coordinate activities (18)
 3 [ ] Establish target dates (19)
 4 [ ] Counsel and advise interested parties (20)
 5 [ ] Legislate the conversion process (21)
 6 [ ] Make conversion mandatory (22)
 7 [ ] Enforce the conversion process (23)
 8 [ ] Other (Please specify) ______ (24)
 9 [ ] None of the above (25)
 10 [ ] No basis to judge (26-27)

6. Do you agree or disagree that the Federal Government should encourage conversion to the metric system by purchasing items designed or described in metric terms? (Please check one.) (28)

 1 [ ] Strongly agree
 2 [ ] Agree somewhat
 3 [ ] Undecided
 4 [ ] Disagree somewhat
 5 [ ] Strongly disagree

B. Status of Metrication

7. Which of the following best characterizes the way your company views itself with respect to metrication? (Please check one.) (29)

 1 [ ] As a leader in metrication, i.e., influencing the decisions of others to go metric
 2 [ ] Following the lead of others in going metric
 3 [ ] Meeting the demands of customers
 4 [ ] Attempting to block or postpone metrication
 5 [ ] Unaffected by metrication
 6 [ ] Other (Please specify) _______

8. What is the current status of each of the following metric conversion activities in your company? (Please check one box for each row.)

	No plans for 1	Plans for 2	In process 3	Completed 4	Does not apply 5	No basis to judge 6	
a. Metric policy statement							(30)
b. Metric coordinator or committee							(31)
c. Customer surveys							(32)
d. Supplier surveys							(33)
e. Cost analysis							(34)
f. Employee training							(35)
g. Consumer information							(36)
h. Funds budgeted for metric conversion activities							(37)
i. Timetable for conversion							(38)
j. Coordination with industry							(39)
k. Coordination with government							(40)

9. For products manufactured in the United States, how are your company's engineering drawings primarily written up? (Please check one.) (41)

1 [ ] In customary units

2 [ ] In dual dimensions (with or without conversion tables)

3 [ ] In metric units

4 [ ] Separate drawings in customary and in metric units

5 [ ] Does not apply

10. For products manufactured abroad, how are your company's engineering drawings primarily written up? (Please check one.) (42)

1 [ ] In customary units

2 [ ] In dual dimensions (with or without conversion tables)

3 [ ] In metric units

4 [ ] Separate drawings in customary and in metric units

5 [ ] Does not apply

11. For production in your overseas plants, what measurement modifications, if any, are made to products manufactured in your U.S. plants? (Please check all that apply.)

1 [ ] Modifications in design (43)

2 [ ] Modifications in packaging and/or labeling (44)

3 [ ] No modifications (45)

4 [ ] Does not apply (46)

12. For products manufactured in your U.S. plants for domestic sale, what measurement modifications, if any, are required to sell those products abroad? (Please check all that apply.)

1 [ ] Modifications in design (47)

2 [ ] Modifications in packaging and/or labeling (48)

3 [ ] No modifications (49)

4 [ ] Does not apply (50)

C. Trade Implications of Metrication

13. How significant are each of the following factors in promoting your exports? (Please check one box for each row.)

FACTORS	Of major significance 1	Of moderate significance 2	Of minor significance 3	No basis to judge 4	
a. Competitive prices					(51)
b. High quality					(52)
c. Superior technology					(53)
d. Good reputation and reliability					(54)
e. Good product maintenance and servicing					(55)
f. Growing foreign market					(56)
g. Vigorous company export promotion					(57)
h. Design/manufacture of products in customary (or English) units and/or engineering standards					(58)
i. Design/manufacture of products in metric units and/or engineering standards					(59)
j. Other (Please specify)					(60)

14. How significant are each of the following factors in deterring your exports? (Please check one box for each row.)

FACTORS	Of major significance 1	Of moderate significance 2	Of minor significance 3	No basis to judge 4	
a. Noncompetitive prices					(61)
b. Strong local and/or third country competition					(62)
c. No quality advantage					(63)
d. No technological advantage					(64)
e. High shipping costs					(65)
f. High tariffs					(66)
g. Nontariff barriers other than measurement standards					(67)
h. Design/manufacture of products in customary (or English) units and/or engineering standards					(68)
i. Design/manufacture of products in metric units and/or engineering standards					(69)
j. Other (Please specify)					(70)

APPENDIX I

15. Would you expect any change in your company's exports as a result of conversion? (Please check one.) (71)

1 ☐ Significant increase
2 ☐ Slight increase
3 ☐ No change
4 ☐ Slight decrease
5 ☐ Significant decrease

16. Would you expect any change in imports into the United States by your overseas competitors as a result of conversion. (Please check one.) (72)

1 ☐ Significant increase
2 ☐ Slight increase
3 ☐ No change
4 ☐ Slight decrease
5 ☐ Significant decrease

17. Do any of the following countries' import regulations related to measurement standards have any impact on the exportation of your products? (Please check one box for each row.)

	Prevention of exports 1	Hampering of exports 2	No significant impact 3	No basis to judge 4	
a. Canada					(73)
b. European Economic Community (Common Market)					(74)
c. Japan					(75)
d. Other (Please specify.) ________					(76)

18. If your company converts to the metric system, would you expect any change in the importation of fasteners and/or other components for your company's products? (Please check one.) (77)

1 ☐ Significant increase
2 ☐ Slight increase
3 ☐ No change
4 ☐ Slight decrease
5 ☐ Significant decrease

19. How significant is the measurement factor in influencing the decision of your company to locate a plant overseas? (Please check one.) (78)

1 ☐ Of major significance
2 ☐ Of moderate significance
3 ☐ Of minor significance
4 ☐ Of no significance
5 ☐ No basis to judge

D. Potential Impact of Conversion

20. Listed below are several ADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether your company would agree or disagree that each would be a significant advantage for YOUR COMPANY. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED ADVANTAGES	Agree 1	Disagree 2	Does not apply 3	No basis to judge 4	
a. The metric system is easier to use and would result in fewer errors					(6)
b. Conversion will increase or protect the present amount of exports and work overseas.					(7)
c. Conversion will provide an opportunity to standardize products.					(8)
d. Trade will be facilitated through a common measurement language					(9)
e. Use of the metric system will increase production efficiencies.					(10)
f. Use of the metric system will facilitate technological advances.					(11)
g. Conversion will provide an opportunity for improving product standards.					(12)
h. Conversion will stimulate your industry.					(13)

21. Listed below are several DISADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether your company would agree or disagree that each would be a significant disadvantage for YOUR COMPANY. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED DISADVANTAGES	Agree 1	Disagree 2	Does not apply 3	No basis to judge 4	
a. Conversion will be costly.					(14)
b. Training employees will be time consuming.					(15)
c. Conversion will result in dual inventories.					(16)
d. Customers will be confused by the metric system.					(17)
e. Conversion will increase the prices of your company's products.					(18)
f. Conversion will result in safety hazards and errors.					(19)
g. Sales will be lost to foreign imports.					(20)
h. Conversion of products will require retesting.					(21)
i. Product standards will have to be changed.					(22)

22. For your company, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.) (23)

1 [ ] Advantages significantly outweigh disadvantages

2 [ ] Advantages slightly outweigh disadvantages

3 [ ] Advantages would be about the same as disadvantages

4 [ ] Disadvantages slightly outweigh advantages

5 [ ] Disadvantages significantly outweigh advantages

6 [ ] No basis to judge

23. For the United States overall, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.) (24)

1 [ ] Advantages significantly outweigh disadvantages

2 [ ] Advantages slightly outweigh disadvantages

3 [ ] Advantages would be about the same as disadvantages

4 [ ] Disadvantages slightly outweigh advantages

5 [ ] Disadvantages significantly outweigh advantages

6 [ ] No basis to judge

24. With respect to small and large firms, who would gain or lose from metric conversion? (Please check one.) (25)

1 [ ] Small firms would gain and large firms would lose

2 [ ] Both small and large firms would gain

3 [ ] Both small and large firms would lose

4 [ ] Small firms would lose and large firms would gain

5 [ ] No basis to judge

25. In the long run, how would metric conversion influence the prices of your company's products? (Please check one.) (26)

1 [ ] Major decrease

2 [ ] Some decrease

3 [ ] Little or no change

4 [ ] Some increase

5 [ ] Major increase

6 [ ] No basis to judge

APPENDIX I

E. Schedules - Time Frames for Metric Conversion

26. If the United States converts to the metric system, approximately what would be the shortest time frame for your company to convert? (Please check one.)

(27)

1 [ ] Less than 5 years
2 [ ] 5 - 10 years
3 [ ] 11 - 15 years
4 [ ] 16 - 20 years
5 [ ] 21 - 25 years
6 [ ] 26 - 50 years
7 [ ] More than 50 years
8 [ ] Never

27. If conversion is not made mandatory, what would be the optimum amount of time your company would need to convert? (Please check one.)

(28)

1 [ ] Less than 5 years
2 [ ] 5 - 10 years
3 [ ] 11 - 15 years
4 [ ] 16 - 20 years
5 [ ] 21 - 25 years
6 [ ] 26 - 50 years
7 [ ] More than 50 years
8 [ ] Never

28. If the United States converts to the metric system, who should establish the date(s) by which your industry would convert? (Please check one.)

(29)

1 [ ] Congress
2 [ ] U.S. Metric Board (in consultation with industry)
3 [ ] Industry associations
4 [ ] Individual firms
5 [ ] Other (Please specify) ________
____
6 [ ] No basis to judge

29. If you have additional comments on any of the items within the questionnaire or related topics not covered, please feel free to express your views in the space below or attach additional data. Thank you very much for your cooperation in completing this questionnaire.

U. S. GENERAL ACCOUNTING OFFICE
METRIC TASK FORCE
SURVEY OF SMALL BUSINESS

INSTRUCTIONS:

Please answer each of the following questions as frankly and completely as possible for the product line representing the greatest volume of sales for your company. We are interested in your company's views whether or not you are active in the area of metric conversion.

We have made the following assumptions so that all respondents will have a common basis for answering:

--Conversion means physical changes, not just substituting metric measurement units for customary or English measurement units (i.e., inch, pound, quart, etc.).

--Conversion does not apply to items already produced or in production.

--During the conversion, purchased parts will be available in metric sizes.

There is space at the end of the questionnaire for any comments you may wish to make concerning these assumptions, the questionnaire, or any other related topics.

The questionnaire is numbered only to permit us to delete your company's name from our list when we receive your completed questionnaire and thus avoid sending you an unnecessary follow up request.

Throughout this questionnaire, there are numbers printed within parentheses to assist our keypunchers in coding responses for computer analysis. Please disregard these numbers.

RESPONDENT INFORMATION:

NAME: ____________________

TITLE: ____________________

TELEPHONE: (   ) ____________________
(Area Code) (Number)

1. What is your type of business? (Please check one. If you engage in more than one type of business, answer for the one which currently provides the greatest gross income.) (6-7)

1. [ ] Manufacturing (including dairy processor, printer, publisher, etc.)
2. [ ] Retail (Please specify kind) ____________________
3. [ ] Wholesale (Please specify kind) ____________________
4. [ ] Service (auto repair, beauty salon, motel, hotel, etc.)
5. [ ] Professional service (doctor, lawyer, etc.)
6. [ ] Mining
7. [ ] Agriculture (farming, logging, etc.)
8. [ ] Transportation, communication, electric, gas or sanitary services
9. [ ] Construction
10. [ ] Financial (insurance, real estate, bank, savings and loan, etc.)
11. [ ] Other (Please specify) ____________________

2. Approximately what was your business gross income (sales) for calendar year 1976? (Please check one.) (8)
   1. /__/ Less than $50,000
   2. /__/ $50,000 to $99,000
   3. /__/ $100,000 to $249,000
   4. /__/ $250,000 to $499,000
   5. /__/ $500,000 to $1,000,000
   6. /__/ More than $1,000,000

3. Approximately how many full time employees are currently on your payroll? (Please check one.) (9)
   1. /__/ Less than 5
   2. /__/ 5 to 24
   3. /__/ 25 to 49
   4. /__/ 50 to 99
   5. /__/ 100 to 250
   6. /__/ More than 250

4. How much thought have you given to the impact on your business of converting from the customary system of measurements to the metric system? (Please check one.) (10)
   1. /__/ Much thought
   2. /__/ Moderate thought
   3. /__/ Little or no thought
   4. /__/ Not concerned for a very good reason (e.g., metric is not here yet, more concerned with getting the work done, no direct impact on my business, don't believe the U.S. will convert, etc.)

5. What is your understanding of the national policy concerning converting to the metric system? (Please check one.) (11)
   1. /__/ No stated national policy
   2. /__/ Mandatory conversion within 10 years
   3. /__/ Federal coordinating and planning of voluntary conversion
   4. /__/ A mandatory, gradual conversion (i.e., more than 10 years)
   5. /__/ No conversion
   6. /__/ Don't know
   7. /__/ Other (Please specify)______________ ______________

6. Which of the following laws or regulations, if any, currently make it difficult for your business to convert to the metric system? (Please check all that apply.)
   1. /__/ Federal antitrust laws (12)
   2. /__/ Other Federal laws (13)
   3. /__/ State and local laws (14)
   4. /__/ Building codes (15)
   5. /__/ Federal or State procurement regulations (16)
   6. /__/ Other (Please specify)_____ ______________ (17)
   7. /__/ None (18)
   8. /__/ No basis to judge (19)

7. Do you agree or disagree that the Federal Government should encourage conversion to the metric system by purchasing items designed or described in metric terms? (Please check one.) (20)
   1. /__/ Strongly agree
   2. /__/ Agree somewhat
   3. /__/ Undecided
   4. /__/ Disagree somewhat
   5. /__/ Strongly disagree

8. If metric conversion occurs, which of the following roles, if any, should the Federal Government assume? (Please check all that apply.)
   1. /__/ Plan the overall conversion (21)
   2. /__/ Coordinate activities (22)
   3. /__/ Establish target dates (23)
   4. /__/ Counsel and advise interested parties (24)
   5. /__/ Legislate the conversion process (25)
   6. /__/ Make conversion mandatory (26)
   7. /__/ Enforce the conversion process (27)
   8. /__/ Other (Please specify)______ ______________ (28)
   9. /__/ None of the above (29)
   10. /__/ No basis to judge (30-31)

APPENDIX II

9. Does your business support or oppose the United States converting to the metric system? (Please check one.) (32)

1. [ ] Strongly support
2. [ ] Somewhat support
3. [ ] Undecided
4. [ ] Somewhat oppose
5. [ ] Strongly oppose
6. [ ] No basis to judge

10. Do you believe that conversion to the metric system is inevitable for your industry? (Please check one.) (33)

1. [ ] Definitely yes
2. [ ] Probably yes
3. [ ] Undecided
4. [ ] Probably no
5. [ ] Definitely no

11. What is the current status of each of the following metric conversion activities in your business? (Please check one.)

	No Plans For	Plans For	In Process	Completed	Does Not Apply	
Estimate cost to convert	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	(34)
Convert or develop products in metric sizes	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	(35)
Convert or obtain equipment in metric sizes	[ ] 1	[ ] 2	[ ] 3	[ ] 4	[ ] 5	(36)

12. Listed below are several ADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant advantage for YOUR BUSINESS. (Please check one box for each row.)

	Agree 1	Disagree 2	Does Not Apply 3	No Basis to Judge 4	
The metric system is easier to use and would result in fewer errors.	[ ]	[ ]	[ ]	[ ]	
Conversion will increase or protect the amount of exports and/or work overseas.	[ ]	[ ]	[ ]	[ ]	(38)
Conversion will provide an opportunity to standardize products.	[ ]	[ ]	[ ]	[ ]	(39)
Use of the metric system will increase production efficiencies.	[ ]	[ ]	[ ]	[ ]	(40)
Conversion will stimulate business.	[ ]	[ ]	[ ]	[ ]	(41)
Use of the metric system will facilitate technological advances.	[ ]	[ ]	[ ]	[ ]	(42)

13. Listed below are several DISADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant disadvantage for YOUR BUSINESS. (Please check one box for each row.)

	Agree 1	Disagree 2	Does Not Apply 3	No Basis to Judge 4	
Conversion will be costly.	[ ]	[ ]	[ ]	[ ]	(43)
Training employees will be time consuming.	[ ]	[ ]	[ ]	[ ]	(44)
Conversion will result in dual inventories.	[ ]	[ ]	[ ]	[ ]	(45)
Customers will be confused by the metric system.	[ ]	[ ]	[ ]	[ ]	(46)
Conversion will increase the price of your business products and/or services.	[ ]	[ ]	[ ]	[ ]	(47)
Conversion will result in safety hazards and errors.	[ ]	[ ]	[ ]	[ ]	(48)
Sales will be lost to foreign imports.	[ ]	[ ]	[ ]	[ ]	(49)
Codes and standards will have to be changed.	[ ]	[ ]	[ ]	[ ]	(50)

4. For YOUR BUSINESS, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

(51)

1. /__/ Advantages significantly outweigh disadvantages
2. /__/ Advantages slightly outweigh disadvantages
3. /__/ Advantages would be about the same as disadvantages
4. /__/ Disadvantages slightly outweigh advantages
5. /__/ Disadvantages significantly outweigh advantages
6. /__/ No basis to judge

5. For the UNITED STATES OVERALL, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

(52)

1. /__/ Advantages significantly outweigh disadvantages
2. /__/ Advantages slightly outweigh disadvantages
3. /__/ Advantages would be about the same as disadvantages
4. /__/ Disadvantages slightly outweigh advantages
5. /__/ Disadvantages significantly outweigh advantages
6. /__/ No basis to judge

16. With respect to small and large firms, who would gain or lose from metric conversion? (Please check one.)

(53)

1. /__/ Small firms would gain and large firms would lose
2. /__/ Both small and large firms would gain
3. /__/ Both small and large firms would lose
4. /__/ Small firms would lose and large firms would gain
5. /__/ No basis to judge

17. If the United States converts to the metric system, who should establish the date(s) by which your industry would convert? (Please check one.)

(54)

1. /__/ Congress
2. /__/ U.S. Metric Board (In consultation with the industry)
3. /__/ Industry associations
4. /__/ Individual firms
5. /__/ Other (Please specify)__________
6. /__/ No basis to judge

18. In the long run, how would metric conversion influence the prices of your business products or services? (Please check one.)

(55)

1. /__/ Major decrease
2. /__/ Some decrease
3. /__/ Little or no change
4. /__/ Some increase
5. /__/ Major increase
6. /__/ No basis to judge

19. If the United States converts to the metric system approximately what would be the shortest timeframe in which YOUR BUSINESS could convert? (Please check one.)

(56)

1. /__/ Less than 5 years
2. /__/ 5 - 10 years
3. /__/ 11 - 15 years
4. /__/ 16 - 20 years
5. /__/ 21 - 25 years
6. /__/ 26 - 50 years
7. /__/ More than 50 years
8. /__/ Never

20. If conversion is not made mandatory, what would be the optimum amount of time your company would need to convert? (Please check one.)

(57)

1. /__/ Less than 5 years
2. /__/ 5 - 10 years
3. /__/ 11 - 15 years
4. /__/ 16 - 20 years
5. /__/ 21 - 25 years
6. /__/ 26 - 50 years
7. /__/ More than 50 years
8. /__/ Never

21. Would you need assistance to finance the conversion to the metric system? (Please check one.)

(58)

1. /__/ Definitely yes
2. /__/ Probably yes
3. /__/ Don't know
4. /__/ Probably no
5. /__/ Definitely no

— If you checked one of these, please skip to question 23.

22. What type of financial assistance would you favor? (Please check one--the primary one.)

(59)

1. /__/ Bank loan
2. /__/ Federal loan
3. /__/ Other (Please specify)______________

____

____

____

APPENDIX II

23. If you have additional comments on any of the items within the questionnaire or related topics not covered, please feel free to express your views in the space below or attach additional data. Thank you very much for your cooperation in completing this questionnaire.

THE FORTUNE 500 INDUSTRIES

Mining, Crude Oil Production
Food
Tobacco
Textiles, Vinyl Flooring
Apparel
Furniture
Paper, Fiber and Wood Products
Publishing, Printing
Chemicals
Petroleum Refining
Rubber, Plastic Products
Leather
Glass, Concrete, Abrasives, Gypsum
Metal Manufacturing
Metal products
Electronics, Appliances
Shipbuilding, Railroad, Trans. Equip.
Measuring, Scientific, Photographic Equip.
Motor Vehicles
Aerospace
Pharmaceuticals
Soaps, Cosmetics
Office Equip. (includes computers)
Industrial & Farm Equip.
Jewelry, Silverware
Musical Instruments, Toys, Sporting Goods
Broadcasting & Motion Picture Prod. & Dist.
Beverages

SMALL BUSINESS PROFILE OF RESPONDENTS

Type of business:	400 sample	1,000 sample
Manufacturing	287	175
Retail	8	119
Wholesale	12	107
Service	2	24
Professional	-	2
Mining	2	2
Agriculture	2	24
Transportation	-	23
Construction	9	67
Finance	-	100
Other	11	45
Total (note a)	333	688
Gross sales:		
Less than $100,000	20	35
$100,000 to $499,999	66	91
$500,000 to $999,999	41	74
$1,000,000 to $4,999,999	132	291
$5,000,000 to $10,000,000	35	120
More than $10,000,000	35	62
Total (note a)	329	673
Number of employees:		
Less than 5	30	45
5 to 24	94	253
25 to 49	73	168
50 to 99	60	142
100 to 250	50	65
Over 250	25	17
Total (note a)	332	690

a/Some respondents did not provide this information: hence, totals do not necessarily agree.

SURVEY OF BUSINESS RESPONSE RATES

	Fortune 500	Small business 400 sample	Small business 1,000 sample
Questionnaires sent	500	400	1,002
Undeliverable/out of business	-	4	41
Potential responses	500	396	961
Usable responses	413	334	693
Response rates:			
Usable responses / Potential responses	413/500 = 82.6 percent	334/396 = 84.3 percent	693/961 = 72.1 percent

NOTES TO APPENDIXES VII, VIII, AND IX

CRITERIA FOR TABLES

Appendixes VII, and VIII

The possible responses to the questions on advantages and disadvantages were agree, disagree, does not apply, and no basis to judge. The positions shown on the tables were determined by using the following criteria:

Agree--greater than 50 percent of the respondents agreed.

Disagree--greater than 50 percent of the respondents disagreed.

Split--neither the agree or disagree responses total more than 50 percent but their combined total was greater than 50 percent.

A blank space means that the combined total of agree and disagree responses was less than or equal to 50 percent.

Appendix IX

For the possible responses to the questions contained on this table, see the discussion of each question in this chapter. Where the answers to the questions contained qualified responses; i.e., somewhat suppport, strongly support, etc., the qualification has been dropped and the responses combined. For example, somewhat support plus strongly support equals support. The last three questions on the table all had possible answers of no plans for, plans for, in process, completed, does not apply, and no basis to judge; the plans for, in process, and completed were combined and represent the "yes" response on the table.

The positions shown on the table were determined by using the following criteria.

--Stated position--The cited position had more than 50 percent of the total response. Note: the word position as used here means any response other than does not apply or no basis to judge.

--Split--No one position had greater than a 50 percent response; but of those taking a position, their

combined total was greater than 50 percent of the total responses.

A blank space means that the combined total of those taking a position was less than or equal to 50 percent.

APPENDIX VII

FORTUNE 500--ADVANTAGES--EACH INDUSTRY'S POSITION

Industry	Opportunity to standardize products	Common measurement language	Easier to use	Improve product standards	Export and work overseas	Increase production efficiency	Facilitate technological advances	Stimulate industry
Mining, crude-oil production		Split	Split					Split
Food	Split	Agree	Split	Disagree	Split	Disagree	Disagree	Disagree
Tobacco			Agree	Split		Disagree		Disagree
Textiles, vinyl flooring	Agree	Agree	Split	Disagree		Disagree	Disagree	Disagree
Apparel	Agree		Agree	Disagree		Disagree	Split	Split
Furniture (note a)								
Paper, fiber, and wood products	Agree	Agree	Split	Split		Disagree	Disagree	Disagree
Publishing, printing			Split					Split
Chemicals	Agree	Agree	Agree	Split	Split	Split	Disagree	Disagree
Petroleum refining	Agree	Agree	Split	Disagree		Disagree	Disagree	Disagree
Rubber, plastic products	Agree	Agree	Agree	Disagree	Split	Split	Disagree	Disagree
Leather (note a)								
Glass, concrete, abrasives, gypsum	Agree	Split	Agree	Disagree	Split	Disagree	Disagree	Disagree
Metal manufacturing	Agree	Agree	Agree	Split	Split	Disagree	Disagree	Disagree
Metal products	Split	Agree	Agree	Disagree	Split	Disagree	Disagree	Disagree
Electronics, appliances	Agree	Agree	Agree	Agree	Split	Disagree	Disagree	Disagree
Shipbuilding, railroad and transportation equipment (note a)								
Measuring, scientific, photographic equipment	Agree	Agree	Agree	Agree	Agree	Disagree	Split	
Motor vehicles	Agree	Agree	Agree	Agree	Split	Split	Split	Split
Aerospace	Agree	Agree	Split	Agree	Disagree	Split	Disagree	Disagree
Pharmaceuticals	Agree	Agree	Split	Split	Disagree	Disagree	Disagree	Disagree
Soaps, cosmetics	Split		Agree	Split		Split		Disagree
Office equipment (includes computers)	Agree	Agree	Agree	Agree	Agree	Split	Split	
Industrial and farm equipment	Agree	Agree	Agree	Split	Split	Split	Disagree	Disagree
Jewelry, silverware			No respondents in this industry					
Musical instruments, toys, sporting goods (note a)								
Broadcasting, motion picture production and distribution			Split					
Beverages	Agree	Split	Agree	Split	Split	Split	Disagree	Disagree

a/Because of the small number of companies in this industry, a breakdown of information is not shown to protect confidentiality.

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APPENDIX VII

FORTUNE 500--DISADVANTAGES--EACH INDUSTRY'S POSITION

Industry	Dual inventories	Costly	Training	Product standards changed	Customers confused	Increase prices	Product retesting	Safety hazard and errors	Sales lost to imports
Mining, crude-oil production	Split	Agree	Agree		Split	Split		Split	
Food	Agree	Agree	Agree	Agree	Agree	Split	Split	Disagree	Disagree
Tobacco	Disagree	Agree	Agree	Disagree		Split	Disagree	Disagree	Disagree
Textiles, vinyl flooring	Agree	Agree	Agree	Agree	Agree		Split	Disagree	Disagree
Apparel	Agree	Agree	Agree	Disagree	Agree	Disagree	Disagree	Disagree	Disagree
Furniture (note a)									
Paper, fiber, wood products	Agree	Agree	Agree	Agree	Agree	Split	Disagree	Disagree	Disagree
Publishing, printing	Agree		Agree					Disagree	
Chemicals	Agree	Split	Agree	Agree	Split	Split	Disagree	Disagree	Disagree
Petroleum refining	Agree	Agree	Agree	Agree	Agree	Split	Disagree	Split	Disagree
Rubber, plastic products	Agree	Agree	Agree	Agree	Disagree	Disagree	Split	Disagree	Disagree
Leather (note a)									
Glass, concrete, abrasives, gypsum	Agree	Agree	Agree	Agree	Agree	Split	Disagree	Disagree	Disagree
Metal manufacturing	Agree	Agree	Agree	Agree	Split	Disagree	Disagree	Disagree	Disagree
Metal products	Agree	Agree	Agree	Agree	Agree	Split	Split	Disagree	Disagree
Electronics, appliances	Agree	Agree	Agree	Agree	Split	Disagree	Split	Disagree	Disagree
Shipbuilding, railroad and transportation equipment (note a)									
Measuring, scientific, photographic equipment	Agree	Disagree	Disagree	Split	Disagree	Disagree	Disagree	Disagree	Disagree
Motor vehicles	Agree	Disagree	Disagree	Agree	Disagree	Disagree	Disagree	Disagree	Disagree
Aerospace	Agree	Agree	Agree	Agree	Split	Agree	Split	Disagree	Disagree
Pharmaceuticals	Split	Agree	Agree	Agree	Agree	Disagree	Disagree	Disagree	Disagree
Soaps, cosmetics	Agree	Agree	Agree	Disagree	Agree	Disagree	Disagree	Disagree	Disagree
Office equipment (includes computers)	Agree	Disagree	Disagree	Agree	Disagree	Disagree	Disagree	Disagree	Disagree
Industrial and farm equipment	Agree	Agree	Agree	Agree	Split	Disagree	Split	Disagree	Disagree
Jewelry, silverware	No respondents in this industry								
Musical instruments, toys, and sporting goods (note a)									
Broadcasting, motion picture production and distribution	Agree	Agree							
Beverages	Agree	Agree	Split		Agree	Agree	Split	Split	Disagree

a/Because of the small number of companies in this industry, a breakout of information is not shown to protect confidentiality.

APPENDIX VIII

FORTUNE 500--OVERVIEW BY INDUSTRY

Industry	Position		Advantages/Disadvantages					Status			
			Weighing of advantages/disadvantages		Changes in						
	Support/ oppose	Inevitable	Business	U.S.	Exports	Imports	Prices	Number of metric leaders	Metric coordinator	Training	Cost analysis
Mining, crude-oil production	Support	Yes	Split	Advantage	No	No	No	None	No	No	No
Food	Support	Yes	Disadv.	Advantage	No	No	No	Three	Yes	No	No
Tobacco	Support	Yes	Split	Advantage	No	No	No	None	Yes	No	No
Textiles, vinyl flooring	Split	Yes	Split	Split	No	No	Split	Two	Yes	No	No
Apparel	Support	Yes	Split	Advantage	No	No	No	One	Yes	No	No
Furniture (note a)											
Paper, fiber, wood products	Support	Yes	Split	Advantage	No	No	No	Two	Yes	No	No
Publishing, printing		Split		Split	No	No	No	None	No	No	No
Chemicals	Support	Yes	Split	Advantage	No	No	No	Four	Yes	Split	Split
Petroleum refining	Support	Yes	Disadv.	Advantage	No	No	No	None	Yes	Yes	Split
Rubber, plastic products	Support	Yes	Advantage	Advantage	No	Split	No	One	Yes	Split	Yes
Leather (note a)											
Glass, concrete, abrasives, gypsum	Support	Yes	Disadv.	Advantage	No	No	No	None	Split	Yes	Split
Metal manufacturing	Support	Yes	Split	Advantage	No	No	No	One	Yes	Split	No
Metal products	Support	Yes	Split	Advantage	No	No	No	Two	Yes	No	Split
Electronics, appliances	Support	Yes	Split	Advantage	No	No	No	None	Yes	Yes	Yes
Shipbuilding, railroad and transportation equipment (note a)											
Measuring, scientific, photographic equipment	Support	Yes	Advantage	Advantage	No	No	No	Two	Yes	Yes	Yes
Motor vehicles	Support	Yes	Advantage	Advantage	No	No	No	Six	Yes	Yes	Yes
Aerospace	Support	Yes	Split	Advantage	No	No	Split	None	Yes	Yes	Yes
Pharmaceuticals	Support	Yes	Split	Advantage	No	No	No	Two	No	Split	Split
Soaps, cosmetics	Support	Yes	Split	Advantage	No	No	No	None	Yes	No	Split
Office equipment (includes computers)	Support	Yes	Advantage	Advantage	Split	No	No	Two	Yes	Yes	Yes
Industrial and farm equipment	Support	Yes	Split	Advantage	No	No	No	Seven	Yes	Yes	No
Jewelry, silverware				No respondents in this industry							
Musical instruments, toys, sporting goods (note a)											
Broadcasting, motion picture production and distribution	Support	Yes	Split	Advantage	No	No	Split	None	No	No	No
Beverages	Support	Yes	Split	Split	No	No	Increase	Two	Yes	Split	Yes

a/Because of the small number of companies in this industry, a breakout of information is not shown to protect confidentiality.

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APPENDIX IX

CHAPTER 6

SIGNIFICANT EFFORT REQUIRED IF ENGINEERING STANDARDS ARE CONVERTED

CHAPTER 6

SIGNIFICANT EFFORT REQUIRED IF ENGINEERING STANDARDS ARE CONVERTED

Engineering standards serve as the keystone to industrial and product development. Broadly speaking, engineering standards are agreements that specify characteristics of things or the way we do things. Engineering standards bring order to the marketplace; without them there would be inconvenience and higher costs, and mass production would not be feasible.

Standards use in the United States is essentially a voluntary matter. Companies or industries which decide to metricate will have to review their engineering standards to determine whether to metricate existing standards; develop new metric standards; or adopt metric standards of other industries, organizations, or countries.

Measurement is an integral part of about one-fourth of all engineering standards. The overall cost to convert or develop metric standards has not been estimated, but is believed to be significant by those involved in standards development. Universal adoption of existing foreign metric standards is not necessarily a viable alternative. However, they can be adopted in some instances (see ch. 7). The time required to convert or develop new standards varies by the interest of the parties and the complexity of the standard. Some standards would not be converted because the change in sizes is not practical.

The ascribed benefits anticipated by metricating engineering standards are increased standardization, revision or elimination of out-of-date or seldom-used standards, and the use of improved technology. However, these are only additional opportunities because they could be achieved without metrication, and their achievement is not assured.

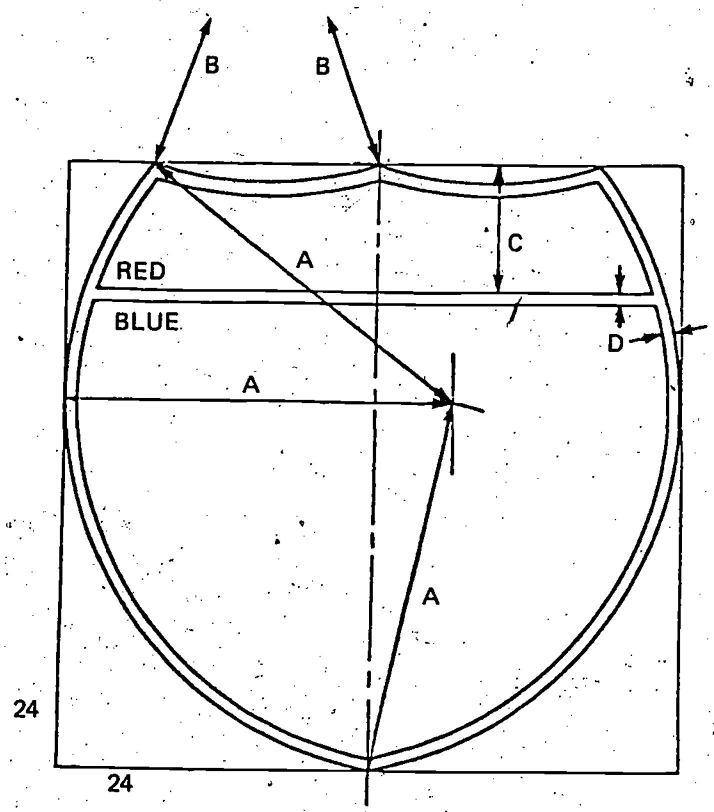
We discussed metrication of standards with U.S. standards writing organizations and various industry representatives. We also reviewed National Bureau of Standards' publications covering metrication and standards.

WHAT ENGINEERING STANDARDS ARE AND WHAT THEY DO

Engineering standards vary from a simple one-page chart to a thick volume with many complex formulas. Standards are used to describe a large variety of items, such as the diameter of wire, size of bolts, wattage of light bulbs, size of

highway signs, technical basis for building codes, tire sizes, and purity of aspirin. Below is an example of a standard for the interstate highway shield, and on the following page is a standard for a hex-headed bolt. The bolt standard is more complex than the highway sign standard.

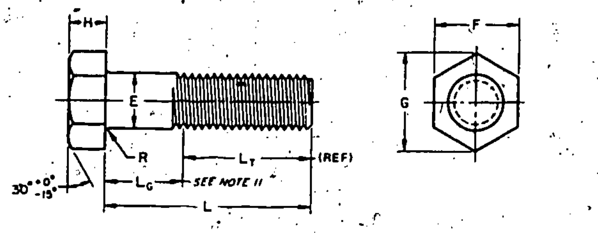
Design Standard for Interstate Highway Shields



	A	B	C	D
24 x 24	15	15	5	½
30 x 24	17	24	5	½
36 x 36	22½	22½	7½	¾
45 x 36	25½	36	7½	¾
48 x 48	30	30	10	1
60 x 48	34	48	10	1

HEX BOLTS

1970 Draft Revision of ANSI B18.2.1 1965



Nominal Size or Basic Bolt Dia	E	F			G		H			R		L_T (Ref)	
	Body Dia	Width Across Flats			Width Across Corners		Height			Radius of Fillet		Thread Length For Bolt Lengths ≤ 6 in.	Thread Length For Bolt Lengths > 6 in.
	Max	Basic	Max	Min	Max	Min	Basic	Max	Min	Max	Min	Basic	Basic
1/4 0.2500	0.260	7/16	0.438	0.425	0.505	0.484	11/64	0.188	0.150	0.03	0.01	0.750	1.000
5/16 0.3125	0.324	1/2	0.500	0.484	0.577	0.552	7/32	0.235	0.195	0.03	0.01	0.875	1.125
3/8 0.3750	0.388	9/16	0.562	0.544	0.650	0.620	1/4	0.268	0.226	0.03	0.01	1.000	1.250
7/16 0.4375	0.452	5/8	0.625	0.603	0.722	0.687	19/64	0.316	0.272	0.03	0.01	1.125	1.375
1/2 0.5000	0.515	3/4	0.750	0.725	0.866	0.826	11/32	0.364	0.302	0.03	0.01	1.250	1.500
5/8 0.6250	0.642	15/16	0.938	0.906	1.083	1.033	27/64	0.444	0.378	0.06	0.02	1.500	1.750
3/4 0.7500	0.768	1-1/8	1.125	1.088	1.299	1.240	1/2	0.524	0.455	0.06	0.02	1.750	2.000
7/8 0.8750	0.895	1-5/16	1.312	1.269	1.516	1.447	37/64	0.604	0.531	0.06	0.02	2.000	2.250
1 1.0000	1.022	1-1/2	1.500	1.450	1.732	1.653	43/64	0.700	0.591	0.09	0.03	[illegible]	2.500
1-1/8 1.1250	1.149	1-11/16	1.688	1.631	1.949	1.859	3/4	0.780	0.658	0.09	0.03	[illegible]	2.750
1-1/4 1.2500	1.277	1-7/8	1.875	1.812	2.165	2.066	27/32	0.876	0.749	0.09	0.03	[illegible]	[illegible]
1-3/8 1.3750	1.404	2-1/16	2.062	1.994	2.382	2.273	29/32	0.940	0.810	0.09	0.03	[illegible]	[illegible]
1-1/2 1.5000	1.531	2-1/4	2.250	2.175	2.598	2.480	1	1.036	0.902	0.09	0.03	3.250	[illegible]
1-3/4 1.7500	1.785	2-5/8	2.625	2.538	3.031	2.893	1-5/32	1.196	1.054	0.12	0.04	3.750	[illegible]
2 2.0000	2.039	3	3.000	2.900	3.464	3.306	1-11/32	1.388	1.175	0.12	0.04	4.250	[illegible]
2-1/4 2.2500	2.305	3-3/8	3.375	3.262	3.897	3.719	1-1/2	1.548	1.327	0.19	0.06	4.750	[illegible]
2-1/2 2.5000	2.559	3-3/4	3.750	3.625	4.330	4.133	1-21/32	1.708	1.479	0.19	0.06	5.250	5.500
2-3/4 2.7500	2.827	4-1/8	4.125	3.988	4.763	4.546	1-13/16	1.869	1.632	0.19	0.06	5.750	6.000
3 3.0000	3.081	4-1/2	4.500	4.350	5.196	4.959	2	2.060	1.815	0.19	0.06	6.250	6.500
3-1/4 3.2500	3.335	4-7/8	4.875	4.712	5.629	5.372	2-3/16	2.251	1.936	0.19	0.06	6.750	7.000
3-1/2 3.5000	3.589	5-1/4	5.250	5.075	6.062	5.786	2-5/16	2.380	2.057	0.19	0.06	7.250	7.500
3-3/4 3.7500	3.858	5-5/8	5.625	5.437	6.495	6.198	2-1/2	2.572	2.241	0.19	0.06	7.750	8.000
4 4.0000	4.111	6	6.000	5.800	6.928	6.612	2-11/16	2.764	2.424	0.19	0.06	8.250	8.500
See Notes 17	7	4										11	

Notes:

1. **Unification. Bold type indicates products unified dimensionally with British and Canadian standards.**
2. Surface Condition. Bolts need not be finished on any surface except threads.
3. Top of Head. Top of head shall be full form and chamfered or rounded with the diameter of chamfer circle or start of rounding being equal to the maximum width across flats, within a tolerance of minus 15 per cent.
4. Head Taper. Maximum width across flats shall not be exceeded. No transverse section through the head between 25 and 75 per cent of actual head height as measured from the bearing surface shall be less than the minimum width across flats.
5. Bearing Surface. A die seam across the bearing surface is permissible. Bearing surface shall be perpendicular to the axis of the body within a tolerance of 3 deg for 1 in. size and smaller, and 2 deg for sizes larger than 1 in. Angularity measurement shall be taken at a location to avoid interference from a die seam.
6. Concentricity of Head. The axis of the head shall be concentric with the axis of the body (determined by one diameter length of body under head) within a tolerance equal to 3 per cent (6 per cent FIR) of maximum width across flats.
7. Body Diameter. There may be a reasonable swell, or fin under the head of die seam on the body not to exceed the basic bolt diameter by the following:

   0.030 in. for sizes up to 1/2 in.
   0.050 in. for sizes 5/8 and 3/4 in.
   0.060 in. for sizes over 3/4 in. to 1-1/4 in.
   0.090 in. for sizes over 1-1/4 in. to 2 in.
   0.120 in. for sizes over 2 in. to 3 in.
   0.190 in. for sizes over 3 in.
8. Point. Bolts need not be pointed.
9. Straightness. Shanks of bolts shall be straight within the following limits: for bolts with nominal lengths to and including 12 in., the maximum camber shall be 0.006 in. per inch of bolt length, and for bolts with nominal lengths over 12 in. to and including 24 in. the maximum camber shall be 0.008 in. per inch of length. A suggested gage and gaging procedure for checking bolt straightness is given on Page A—23.
10. Length Tolerances. Bolt length tolerances are given on Page A—22. Tolerances for non pointed products shall apply.
11. Thread Length. The length of thread on bolts shall be controlled by the grip gaging length L_G max as set forth in the following:

    Grip Gaging Length, LG max, is the distance, measured parallel to the axis of bolt, from the underside of the head to the face of a non-counterbored or non-countersunk standard GO thread ring gage assembled by hand as far as the thread will permit. The maximum grip gaging length, as calculated and rounded to two decimal places, for any bolt length shall be equal to the nominal bolt length minus the basic thread length (LG max = L nom − L_T). It represents the minimum design grip length of the bolt and shall be used as the criteria for inspection and for determining thread availability when selecting bolt lengths even though usable threads may extend beyond this point.

    All bolts of nominal lengths equal to or shorter than the basic thread length, L_T plus a length of 2-1/2 threads for sizes up to and including 1 in., and L_T plus 3-1/2 threads for sizes larger than 1 in. shall be threaded for full length. The distance from the bearing surface of the head to the first complete (full form) thread, as measured with a GO thread ring gage assembled by hand as far as the thread will permit, shall not exceed the length of 2-1/2 threads for sizes up to and including 1 in., and 3-1/2 threads for sizes larger than 1 in.

    Basic Thread Length, L_T, is a reference dimension, intended for calculation purposes only, which represents the distance from the extreme end of the bolt to the last complete (full form) thread.
12. Incomplete Thread Diameter. The major diameter of incomplete thread shall not exceed the actual major diameter of the full form thread.
13. Threads. Threads, when rolled, shall be Unified coarse, fine or 8 thread series (UNRC, UNRF or 8 UNR Series), Class 2A. Threads produced by other methods may be Unified coarse, fine or 8 thread series (UNC, UNF or 8 UN Series), Class 2A.
14. Reduced Diameter Body. Bolts may be obtained in "reduced diameter body". Where "reduced diameter body" is specified, the body diameter may be reduced to approximately the pitch diameter of the thread. A shoulder of full body diameter under the head may be supplied at option of the manufacturer.
15. Identification Symbols. Identification marking symbols on the tops of heads for bolt sizes 5/8 and smaller shall project not less than 0.005 in. above the surface nor more than 0.015 in. over the specified maximum head height; and for bolt sizes larger than 5/8 in. shall project not less than the equivalent in inches of 0.0075 times the basic bolt diameter above the surface nor more than 0.030 in. over the specified maximum head height. ASTM and SAE grade markings for steel bolts are given on Page N—20.
16. Material. Unless otherwise specified, chemical and mechanical properties of steel bolts shall conform to ASTM A307, Grade A. (See Page N—20). Other materials shall be as agreed upon by manufacturer and purchaser.
17. Nominal Size. Where specifying nominal size in decimals, zeros preceding the decimal and in the fourth decimal place shall be omitted.
18. See Introductory Notes and General Data on Page A—3.
19. Weights. Weights given on Page N—90.

The use of engineering standards which leads to standardization greatly simplifies commerce in a highly industrialized society. The absence of standards would greatly complicate the tasks of the buyers and producers in satisfying their needs. Standards provide

--improved communication between buyer and seller;

--greater confidence in the commodity purchased;

--better understanding of how to use the commodity;

--greater public safety in the use of the commodity;

--better quality control;

--lower inventories for both producer and user through elimination of unnecessary sizes, styles, and grades;

--earlier deliveries because of ability to stock common items;

--better performance at lower prices through reduced need for negotiations and more efficient inspection and testing; and

--lower prices through more rational basis for competitive bidding.

For example, a consumer buying a lamp for home use usually assumes the plug will fit the electrical outlet, a lightbulb will fit the lamp socket, and the lightbulb will not immediately burn out or explode when the switch is turned on. The consumer can take these things for granted, for the most part, because the producers of power generators, electrical transformers and wiring, wall sockets, electrical fuses, lamps, and light bulbs all use engineering standards which ensure the consumer that the lamp will work and work safely.

When manufacturers produce similar items using different engineering standards, the result can mean added costs and inconvenience for the consumer. For instance, the buyer of a a new battery-operated calculator may not be able to recharge the battery by using the charging unit for another calculator because the units are not standardized. The buyer may find that the two charging units are designed to fit the home electrical outlets. Both convert household current into useable current for the calculators, and both may be identical in many other ways. However, the size of the plug which fits into the calculator and the output of the charging units may be different. Thus, the two units are not interchangeable.

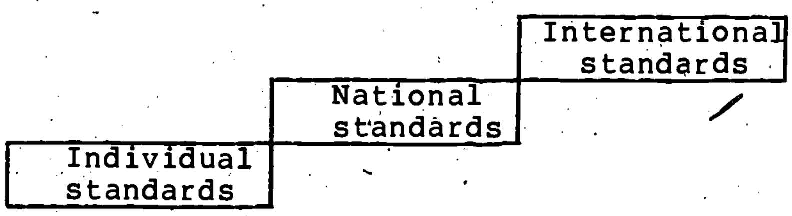
Why is it that the lamp buyer can be secure in the knowledge that everything will fit and work properly and the calculator buyer cannot? The answer lies in the manner in which engineering standards are developed, promulgated, and adhered to in the United States.

DEVELOPMENT PROCESS FOR ENGINEERING STANDARDS

Engineering standards are developed and published at essentially three levels: a single organization, company, or local group; a national organization, professional standards writing organization, or trade association; and an international organization or international standards writing organization.

The following chart depicts the voluntary standards development staircase. Information on standards flow up and down the staircase, and the acceptance and use of the standards depends on the individual parties in the process.

Voluntary Standards Development Staircase



Metrication of engineering standards in the United States will involve all of the above levels. However, the degree of coordination between the three levels varies widely. The least coordination exists at the individual organization development level. Coordination is greater at the national level and potentially the greatest at the international level. When numerous individual engineering standards are used rather than national or international standards, an excessive variety of products may occur and replacement parts may be difficult to obtain.

In the United States engineering standards development is primarily voluntary as is adherence to these standards. Groups join together on a voluntary basis to negotiate an engineering standard; and unless a standard is cited in a law, regulation, building code, or contract, no one is compelled to use or comply with it.

In addition to the many individual companies who develop their own standards, over 580 groups in the United States--professional societies, trade associations, State governments, and Federal Government agencies--write, disseminate, or participate in standardization activities. Also, an estimated 12,000 local governmental bodies issue building codes and regulations.

International standards are developed by multinational organizations. Both the public and private sectors participate in international standards setting activities. Generally, the Federal Government represents the United States in international standards organizations, such as the General Conference of Weights and Measures, which have been established by treaties. The American National Standards Institute, a private nonprofit organization, represents the United States in international standards organizations which have not been established through treaties.

<u>How voluntary engineering standards become national or international standards</u>

Two means exist for a voluntary engineering standard to become a national or international standard. One is through wide acceptance of the standard by various companies and industries. These are sometimes referred to as de facto national or international standards. The other means is through formal recognition by a national or international standards writing organization.

In the United States the Government does not publish or promulgate national standards as some other countries do. ANSI is the only U.S. standards-promulgating organization whose goals and objectives are to provide formal recognition of standards as national standards. ANSI writes no standards; however, it provides a medium for coordinating standards development and agreement on national standards. The standards it approves bear the name, "American National Standard."

ANSI's membership consists of 900 companies and 200 trade, technical, professional, labor, government, and consumer organizations. It has established formal review procedures for use in considering proposed national standards, and it requires formal voting and resolution of objectives before approving a standard. It has approved about 6,500 engineering standards as American National Standards.

The International Organization for Standardization (ISO) and the International Electrotechnical Commission are the

principal international organizations involved in preparing voluntary engineering standards. Membership in these is limited to national representatives of member countries. ANSI is the U.S. representative. ISO has 81 member nations, and the Commission has 42.

The Commission is concerned with electronic and electrical standards, and ISO is concerned with all other types of standards. These international organizations have published about 1,500 and 2,800 standards, respectively.

Time required to develop standards

Standards development is a labor-intensive and time-consuming process. It requires the interested parties to meet and reach agreement on the standard. Standards writers told us that it usually takes between 2 to 5 years to develop and process a new standard. This time is spent to develop the technical information and to obtain agreements on the standard. Standards development is also a continuous process. Organizations generally review their standards every 3 to 5 years to reaffirm or revise them.

Organizations believe that the metrication of engineering standards would be done when the standards are being reviewed or updated. They generally believed that a special program to metricate standards would be too costly. The time required to convert a standard depends on the interest of participants and the complexity of the standard, according to an official of one large standards writing organization. However, in his opinion, the time required to convert a standard should be less than that required for developing a new one.

If an international agreement on a standard is sought, additional time is required. We were informed that obtaining international agreement on a standard requires an additional 2 to 5 years.

VIEWS VARY ON NEED TO CONVERT STANDARDS

Proponents of metrication point out that as the world becomes increasingly metric, the need for the United States to use the metric system increases. U.S. engineering standards are based on the customary system and generally are not compatible with standards based on the metric system. The importance of the compatibility of engineering standards is increasing in European markets. This is signaled by actions of the European Economic Community countries. Policies of the Community suggest the increased adoption of international standards as national standards.

The use of international standards can broaden competition by assuring buyers and producers consistent products and materials which meet their needs regardless of country of origin, according to standards organizations. Also, their use can reduce trade problems. Generally, the parties interested in international standards are those involved in international trade.

In our questionnaire to firms listed in the Fortune 500 (see ch. 5), we sought opinions on the importance of measurement units and/or engineering standards in trade. Most of the respondents stated that measurement units and engineering standards, customary or metric, were of minor significance in promoting or deterring exports.

Metric terms used internationally

Use of the International System of Units is increasing in international trade and standards. The Department of Commerce advises U.S. exporters that most foreign countries issue product standards which use hard metric dimensions. Further, U.S. products must conform to each country's laws and regulations and be compatible with products used in those countries. However, many U.S. engineering standards, such as those used in the aerospace and petroleum industries, have been accepted internationally because of the U.S. technological lead. These engineering standards are soft converted to metric terms by other countries or international organizations if necessary.

In 1971 the European Economic Community issued a directive establishing that all commercial transactions between the members be conducted in SI units. This, coupled with greater international standardization in the Community, leads to the possibility that U.S. products will be required to meet metric engineering standards.

Finally, ISO and the International Electrotechnical Commission have adopted the SI system as the official measurement language for their standards. European countries are beginning to use SI units in their national standards. This means that standards written in U.S. customary units are losing international acceptability, according to standard writers. However, the extent to which other countries use and adhere to international standards has not been ascertained, according to NBS.

INTERNATIONAL STANDARDS CAN BE SOURCE OF METRIC STANDARDS

Most foreign engineering standards are in metric units. This means that the United States has the option of adopting the foreign metric engineering standards, rather than developing its own.

International and foreign standards are criticized for not always being technically adequate for use in the United States. However, an ANSI official said that there is a lot of truth in the point, "If I did not write the standard, I do not use it." We did not judge the validity of the criticisms. Some criticisms of the ISO's standards are:

--They are the lowest common denominator of the countries involved; that is, to satisfy all parties, the standard approved may reflect a lower technology level than possible.

--They are out of date by the time published.

--The European members use block voting to ensure their views.

--Too little U.S. participation exists in the development of standards to endorse their use in the United States.

As will be discussed in chapter 7, the U.S. fastener industry tried to develop a new international standard for metric fasteners but eventually adopted the international standard with some exceptions.

Standards conversion in other countries

The metrication of engineering standards was one of the early conversion projects started in the United Kingdom, Australia, and Canada. Essentially, these governments left the actual conversions up to industry and the national standards writing organizations. The use of national standards in these countries, as in the United States, is voluntary.

However, the degree of government involvement in standards development in these countries is greater than in the United States. In the United Kingdom and Australia, the national standards coordinating body is a government agency; it receives funds from both the government and the private sector. Canada used its metric conversion commitment, in part, to introduce government review and involvement of its voluntary standards development system. The Standards

Council of Canada was established at the onset of its metrication commitment as the national coordinating agency for standardization. Its purpose is to encourage the writing of standards through the voluntary consensus process. The Council certifies standards writing organizations and ensures that a consensus standard is produced. It manages the national standards of Canada. Also, the Council has the responsibility for representing Canada in the international standards organizations. Thus, these governments are able to direct the standards development toward metrication.

However, in the United States, the Federal Government neither coordinates national standardization activities, reviews the standards development processes, nor certifies standards writing organizations. Although Federal agencies develop standards, their use is not mandatory unless cited in laws, regulations, and contracts. Legislation introduced in the Congress in 1976 and 1977 proposing more Federal Government involvement and review of standards development was not enacted. 1/

NUMBER OF ENGINEERING STANDARDS AND THE METRIC IMPACT

In 1971 NBS reported that about 60,000 engineering standards were being used as national standards. About two-thirds of these had been issued by the Federal Government and one-third by various standards writing groups in the private sector. NBS estimated that only about one-fourth of the engineering standards were measurement sensitive; that is, measurement was an integral part of the engineering standard.

To evaluate the impact of metrication of engineering standards, NBS categorized the types of standards into uses and purposes as follows:

1. Dimensional standards specify the uniform size for products or items. For example, a specific width for the distance between rails for railroads has been established.

2. Quality standards assure a desired quality level for a required service and uniformity in quality from one item to another. However, quality standards are not measurement sensitive because they prescribe a degree of quality. For example, if an engineer determines that a bolt must have a strength of 120,000

1/S. 3555, 94th Cong. 2d Sess. (1976)
S. 825, 95th Cong. 1st. Sess. (1977)

pounds per square inch, this requirement is the same whether the strength is reported as 827,000 kilopascals (metric) or 120,000 pounds per square inch.

3. Methods of test standards provide a common basis for evaluating materials and products. These establish normalized procedures for determining critical dimensions or product quality and are essential for ascertaining if a product satisfies a specification.

4. Descriptive standards are comprised of those engineering practices which do not involve measurement units. They include symbols, sampling and other statistical practices, terminology and definitions, format for drawings, and other descriptive engineering practices. Examples are the glossary of terms, the color code of similar products, the list of symbols or abbreviations used in a standard, and the sample size to estimate quality of a lot.

In addition, design and performance standards exist which incorporate the above categories of standards. Design standards impose limits on product design or materials used. Performance standards describe how a product or material should behave under certain conditions.

Engineering standards can be based on any system of measurement units, and the values can be converted from one system to another. The use of a common measurement system could eliminate both errors that may be made when converting between systems and the staff-hours required to make the conversions.

When customary values are converted to metric values in an engineering standard, the process is referred to as soft conversion. Essentially, no physical change takes place in the products. Some standards, such as the distance between rails for a railroad, would only be soft converted because it would be impractical to change the distance. However, some standards organizations explained that this type of conversion is of little value because it takes time to make the calculations and no change occurs except in measurement language.

The alternative process is called hard conversion. It calls for new standards because a physical change would take place in the products. Hard metric standards are not compatible with customary standards because the values commonly used are not equal. Some examples of units commonly used in standards are shown on the following page.

Unit	Customary units	Soft-converted metric units	Typical rounded metric units
length	1/4 in	6.4 mm	5 mm
	1/2 in	12.7 mm	10 mm
	1 in	25.4 mm	25 mm
	2 in	50.8 mm	50 mm
	4 in	101.6 mm	100 mm
weight	4 oz	113.4 g	100 g
	8 oz	226.8 g	250 g
	16 oz or 1 lb	453.6 g	500 g
	2 lb	907.2 g	1 kg
	4 lb	1.8 kg	2 kg
volume	4 oz	118.3 mL	125 mL
	8 oz	236.6 mL	250 mL
	16 oz	473.2 mL	500 mL
	1 qt (32 oz)	946.4 mL	1 L
	2 qt (64 oz)	1.89 L	2 L
	1 gal (4 qt)	3.79 L	4 L
	2 gal	7.57 L	8 L

Consequently, if U.S. industry needs metric standards which are compatible with standards of metric countries, hard conversion will be necessary.

Few U.S. metric standards exist

Few U.S. standards are based on metric units. ANSI's bibliography of metric standards lists 16 American National Standards as metric. However, one large standards writing organization says that its 5,000 standards show both customary and metric units. These are soft-converted standards.

We have no estimate on the total number of engineering standards which are being converted. Generally, standards writing organizations said that the decision to convert a standard is up to its members and the indicated needs of the marketplace. As will be discussed in other chapters, some industries have started projects for converting their standards.

Advantages and disadvantages

The often-cited benefits or advantages of converting engineering standards are expressed as opportunities. These opportunities are increased standardization of products or things, reduced number of standards, and improved technology in standards. Most of these opportunities can be attained without metrication, we have been told. However, metric proponents state that conversion provides the incentive to attain them.

Standards writers generally believed that there was excessive duplication in standards development. However, this appears to be a problem of the voluntary standards development process in the United States. Because not all standards are measurement sensitive, we doubt that metrication will resolve this situation.

In our questionnaire to the companies listed in the Fortune 500, we asked for opinions on several of the frequently attributed advantages of metrication. Most respondents believed that conversion provides the opportunity to standardize products. However, more disagreed than agreed that metrication provides an opportunity to improve the existing standards which have been developed for products. On whether metrication will improve technological advances, most of the respondents indicated that they did not believe it would. The following table shows the respondents opinions on the claimed advantages.

Advantages	Agree	Disagree	Does not apply	No basis to judge
	(percent)			
Conversion will provide an opportunity to standardize products	61	18	16	5
Conversion will provide an opportunity for improving product standards	36	43	11	10
Use of the metric system will facilitate technological advances	13	57	14	16

In our Fortune 500 questionnaire, we also asked about disadvantages in metrication. One of the frequently attributed disadvantages cited about metrication is that product standards will have to be changed--60 percent of the respondents to our questionnaire agreed with this point. However, 27 percent disagreed and 13 percent responded that they either had no basis to judge or the question did not apply to them.

COST TO METRICATE STANDARDS

While we could not identify the overall cost of converting standards, we did obtain some estimates. According to a report on the development of a U.S. metric fastener standard, the U.S. industry had invested $1 million on the development of a new metric engineering standard for fasteners. The Aerospace Sector Committee of the American National Metric Council has estimated that the U.S. aerospace industry could spend about $29 million for the conversion of some 4,000 standards. Also, we noted that the average cost to develop or revise any General Services Administration standard was about $17,200 and about $6,800, respectively, in fiscal year 1976.

The type of conversion is an important factor in the cost of conversion. Soft conversion could involve many staff-hours to replace the customary values with equivalent metric values and to validate computations, according to standards writers. Hard conversion would require the development of a new standard. Generally, hard conversion would seem to be more costly than soft conversion.

According to an ANSI official, to achieve the benefits of metrication, U.S. industry may have to double or even triple its commitment of funds and resources for standards development over the next 10 years. In this official's opinion, such a commitment to standards development may ensure that conversion is a blessing rather than a nightmare for business and the public alike. In 1976 ANSI estimated that the U.S. industry commitment to standards development was more than $250 million annually.

VIEWS OF STANDARDS WRITERS

We contacted a number of nationally recognized standards organizations. Generally, these organizations have policies to develop whatever standards are sought by industry. Their policies may be providing some impetus for metrication in the United States.

ANSI

ANSI's policy is that a standards writing organization, at a minimum, should include at least dual dimensions in its standards and suggests developing metric standards which are parallel to existing customary standards. This position is based on the belief that U.S. standards must be compatible with international standards. Further, ANSI believes that the importance of international trade is on the rise and the United States may suffer if U.S. products and standards are not compatible with those of the rest of the world.

American Society for Testing and Materials

The Society for Testing and Materials is the largest voluntary standardizing organization in the United States. Its standards deal with the characteristics and testing of a material, product, system, or service. For example, it publishes standards on specifications of materials like steel and cement. It has published about 5,000 standards; many are recognized as American National Standards.

The Society for Testing and Materials is a proponent of international standardization. In 1963 it took a leading position by introducing SI metric units in its standards along with the customary units. Also, it has published a metric practice guide to assist its technical committees conversions. This guide has been an approved American National Standard since 1973.

A representative from the Society for Testing and Materials views soft conversion and dual dimensioning of standards as an educational exercise. The Society for Testing and Materials hopes to use dual dimensioning only as an intermediate measure. As of September 1977, nearly all of its 5,000 standards include dual units, and one standard has been converted. (A converted standard is defined as one which parallels an existing customary standard.) Six other standards are in the process of being converted. The Society for Testing and Materials did not know how many standards are based on metric units but was keeping track of converted standards.

The Society for Testing and Materials is following a policy of converting standards when an industry or the standards committees want them converted.

American Society of Mechanical Engineers

The American Society of Mechanical Engineers is a professional society with about 70,000 members. It promotes the

art and science of mechanical engineering and related sciences. It is probably best known for its Boiler and Pressure Vessel Code which has been accepted as law, in part or in whole, by 45 States, a number of cities, and all provinces in Canada.

According to its first metric policy, published in 1970, the Society of Mechanical Engineers anticipated displacement of the U.S. customary measurement system by the SI metric system in many fields. Its policy encouraged the development by its members of a capability to work in both systems. In October 1975 the policy was revised to state that the Society of Mechanical Engineers supports a coordinated voluntary national conversion program and that it will cooperate with others in implementing the policy. Further, the Society of Mechanical Engineers required all works to include metric units, but customary units could also be used.

In April 1977 the Society of Mechanical Engineers amended its policy to provide that its codes and standards be published in metric units at the appropriate time as determined by industry, Government, public, and society needs consistent with national plans for coordinating and managing development of metric standards. An official explained that the previous policies had placed emphasis on soft conversion of standards. The Society of Mechanical Engineers found little value in soft conversion except for education and familiarization because little or no change occurs. Soft conversions result in arithmetic exercises, according to an official. Anyone measuring a product made to a soft-converted standard would consider the product customary rather than metric. The official stated that interest in metrication has tapered off considerably.

Before the 1977 policy change, the Society of Mechanical Engineers had started soft converting information in its boiler and pressure vessel code. It had not expected to complete this conversion until 1981. The Society of Mechanical Engineers was not converting any formulas in the code, we were told, because it doubts it could be done economically.

American Society of Heating, Refrigerating, and Air-conditioning Engineers

This society, which has about 25,000 members, has published about 70 testing standards; that is, methods to test products. In June 1975 it issued the following schedule promoting soft conversion of its standards:

1. After July 1, 1976, all publications, with the possible exception of the handbook volumes and special tabular publications, shall be prepared using SI

metric or dual units. The sequence of the units shall be left to the discretion of the author.

2. After July 1, 1977, all publications shall be prepared using metric units only or metric units first followed by U.S. customary units in parentheses.

3. After July 1, 1979, all publications shall be prepared using metric units only.

The Society of Heating, Refrigerating, and Air-conditioning Engineers considered soft conversion as a vehicle for metric education. An official told us in February 1978 that this schedule has been rescinded. Some strong resistance to the schedule had been voiced by the air-conditioning systems and equipment group, particularly contractors.

Each group within the Society of Heating, Refrigerating, and Air-conditioning Engineers has responsibility for its standards and publications and will determine when to convert. Before a standard or publication is printed using only metric units, it must be approved by the Board of Directors.

Institute of Electrical and Electronic Engineers

The Institute of Electrical and Electronic Engineers is a professional engineering society with about 175,000 members. It writes standards on electronic and electrical equipment; testing and rating methods; and units, symbols, and definitions.

The Institute's policy provides for the use of SI metric units in its publications and standards. But if a variation is necessary, the policy requires the units to be converted to metric units. The Institute prefers hard conversion but recognizes problems with other standards, such as wire sizes, national wire code, and heavy electrical equipment, which it does not prepare.

An official pointed out that the electrical field is not faced with making as many conversions as other engineering fields because the measurement units of volt, ampere, and watt are customary as well as metric units. The official said that the electrical field is moving toward greater acceptance of metric units with modest speed.

Underwriters Laboratories Incorporated

Underwriters Laboratories' purpose is to establish, maintain, and operate laboratories for the investigation of materials, devices, products, equipment, constructions, methods, and systems with respect to hazards affecting life and property. It tests the quality of items against standards, such as its safety standards for electric heating pads, household dishwashers, and life preservers.

Underwriters' practice is to include SI units parenthetically in its standards along with the customary units. Metric units which differ from SI units are still in common usage in foreign countries, and these units are also listed in some cases.

Underwriters' position is to be a follower in metrication rather than a leader. It will provide whatever the market dictates, which has been its policy in the past, according to an official. It anticipates no problems with conversion.

Society of Automotive Engineers

The Society of Automotive Engineers, a professional engineers organization, develops technical standards for industries using internal combustion engines, such as the motor vehicle, farm tractor, aerospace, and road building industries.

In 1969 the Society of Automotive Engineers issued a statement calling for SI metric units to be used in its standards and other technical reports. Its December 1976 policy recognized the rapid growth of metric usage, particularly in the industries it serves. The Society of Automotive Engineers is working toward the gradual phaseout of customary units by 1985. It places importance on increasing compatibility of U.S. standards with international standards and promoting wider acceptance of international standards whenever practical.

Federal Government standards

In 1971 NBS estimated that about 40,000 engineering standards used in the United States were issued by the Department of Defense and the General Services Administration. These standards are used primarily in Government procurement. Officials of these agencies informed us that their agencies intend to follow industries lead in converting and not lead themselves. The officials pointed out that generally their agencies rely on industry for products and are not in the position

to dictate metric products and standards. (See ch. 22 for more detail on Federal agencies and metrication.)

CONCLUSIONS

Metrication of U.S. engineering standards is not necessary to increase standardization, rationalize existing standards, enable reviews of existing standards to see which are outmoded and should be eliminated or revised, and improve technology. Metrication could cause standards organizations and industry to take a more penetrating look than they otherwise might, but other events also could cause these to occur under the customary measurement system.

Metric conversion would require an evaluation of measurement-sensitive standards. In some instances soft conversions would be made because it is not practical to make dimensional changes to the items involved. In other cases, new standards would need to be developed based solely on metric terms, particularly if U.S. industry wants engineering standards which are compatible with those used in international trade.

Soft conversion is considered by some to be a potential waste of resources because no physical change occurs in the standard or eventual product. However, soft conversion offers educational experience for standards writers by familiarizing them with using metric units in place of the more familiar customary units. Standards writing organizations tend to favor hard conversions.

If compatibility of U.S. and international standards is required for international trade, it appears that adopting the SI metric system would improve the communications in standards. Also, complete conversion would eliminate the errors and the time required to work with two measurement systems. However, major U.S. industrial firms said that measurement and engineering standards are not major factors in international trade.

A few standards in use in the United States have been converted, and most of the standards organizations we contacted have established policies on use of metric terms. Implementation of some policies is moving slower than originally planned because conversion is not occurring as fast as some groups had expected.

The overall costs of converting standards are unknown but expected to be significant--several billions of dollars. The time required to convert a standard or develop a new standard varies widely depending on the interest of the participants

and the complexity of the standard. Generally, the time required to develop a new standard can vary between 2 to 5 years. Obtaining international agreement could add from 2 to 5 more years to the process. The time required to convert standards will have an impact on the conversion period. International standards could be adopted, but this is not necessarily a viable alternative.

CHAPTER 7

FASTENER INDUSTRY GETS READY

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The U.S. fastener industry, which was originally opposed to metrication, began conversion efforts in 1970 in order to maintain its markets. Its major customers were beginning to move toward using the metric system in the late 1960s. The achievements and problems of this industry offer insights to other industries contemplating conversion and provide an example of the extent to which the purported benefits of metrication, such as increased standardization (use of standards) and rationalization (reduction of items) may or may not be realized.

We held discussions with officials of fastener producing companies, the Industrial Fastener Institute, American National Standards Institute, Federal agencies, and manufacturers that use fasteners in their products. Pertinent documents were also reviewed.

WHAT IS A FASTENER?

A fastener is anything which holds two things together. Nuts, bolts, screws, rivets, cotter pins, and nails are a few examples. (See following page.) Of these, the United States produces approximately two million different types. Fasteners can hold together a vast number of items. For example, a telephone is held together with about 70 fasteners. Jumbo jets contain millions; and for one model, fasteners costs represent about 10 percent of the plane's total cost. In short, much of the nearly $2 trillion U.S. economy is held together by the $2 billion fastener industry.

We concentrated on threaded fasteners--nuts, bolts, and screws--because they are more affected by dimension changes. In these fasteners dimensions are critical, and close tolerances must be met. Although generally thought of as a simple product, threaded fasteners are the result of much engineering and testing and are important to industry. Yet, most cost only a few cents.

THE FASTENER MANUFACTURING INDUSTRY

In 1976 the U.S. fastener manufacturing industry had about 500 companies with 600 plants and 50,000 employees. It produced about 250 billion fasteners. The industry produces about 500,000 different standard fasteners and about 1 to 1.5 million various nonstandard fasteners.

The industry has no giants. About one-half of the companies employ fewer than 20 persons each. The industry supplies and serves all other industries, from original equipment manufacturers to replacement suppliers. Original equipment manufacturers consume nearly 85 percent of the industry's production.

According to fastener industry sources, foreign competition, notably from Japan, has taken its toll in recent years. Since 1969, 15,000 American fastener workers have lost their jobs. Imported nuts, bolts, and cap screws have now captured 50 percent of the U.S. market for these products.

Officials describe the industry as sandwiched between big businesses. Most raw materials are purchased from the big steel companies, and the final product is sold to the large manufacturers and major distributors. When they buy, it is a seller's market; when they sell, it is a buyer's market.

Increasing use of metric fasteners

In the past only imported products, such as automobiles, bicycles, and industrial equipment, contained metric-threaded fasteners. Products made in the United States generally contained customary-threaded fasteners. If U.S. industries convert, an increasing number of metric-threaded fasteners will be used. However, the decisions to use either customary- or metric-threaded fasteners are made by individual manufacturers, and not by the fastener producers.

Before the late 1960s, the U.S. fastener industry opposed metrication because it considered the customary-dimensioned fasteners to be technologically superior or equal to metric-dimensioned fasteners. Also, the industry had developed substantial experience and confidence in customary fasteners. However, in the late 1960s the industry found that many of its major customers were contemplating conversion. Already troubled with losing customary fastener markets to imports, the fastener industry set out to protect its total market share by preparing to meet the anticipated demand for metric fasteners by U.S. manufacturers.

Metric fastener use varies. For example, metric fasteners are being used by U.S. manufacturers in vehicle bodies, engines, pumps, and transmissions. As manufacturers metricate, both customary and metric fasteners may be used in products for an extended period of time. It has been estimated that this mixture will continue for about 8 to 10 years in

automobiles and farm and construction equipment. One automobile company used about 60- to 70-percent metric fasteners in its 1978 passenger vehicles. Another used about 10 to 15 percent; and a third, only a small amount.

ENGINEERING STANDARDS PLAY AN IMPORTANT ROLE IN METRICATION

When officials of the fastener-producing industry decided that fastener metrication was inevitable, they looked to their standards program as the logical place to begin the conversion process. Before they could build a metric fastener, they had to have a metric engineering standard.

Engineering standards govern, in part, the design, production, and use of a product. The absence of these standards would greatly complicate the tasks of the industrial consumer in specifying his needs and of the producer in meeting those needs. Standards also provide a means for improved communications in the marketplace and instill a greater confidence by establishing product uniformity and minimum quality levels. Standards may help lower prices by eliminating excessive numbers of product styles and grades.

Standards are written by individual companies, industries and trade associations, government bodies, national organizations, and international groups. Unless these standards are specified in a contract, building code, regulation, or law, no one is compelled to use them.

In the late 1960s, a U.S. engineering standard for metric-fasteners did not exist; however, an international standard was available. U.S. industry officials claimed that this standard contained too many sizes and thread types, and the progression of sizes did not follow a logical pattern. The officials reasoned that, as long as U.S. industry was going to metricate, it should attempt to develop a new fastener system which was as perfect as possible. Also, the industry did not want to give a competitive advantage to foreign producers of metric fasteners. It was felt that the foreign producers would gain an advantage if the U.S. industry merely accepted the existing international standard for metric fasteners in its entirety.

The search for the optimum metric fastener system

In 1970 the Industrial Fasteners Institute, a producers' trade association, conducted a study on an optimum metric

fastener system. Its goal was the development of new metric-fastener standards which would simplify fastener sizes and styles, reduce fastener costs, result in technical improvements, and gain national and international acceptance. The Institute published a report in January 1971 entitled "A Study To Develop An Optimum Metric Fastener System."

The report recommended that a new metric-threaded fastener system be established. The proposed system offered significant reduction in fastener sizes and the number of thread types. In the size range of 1 millimeter to 100 millimeter (about 0.04 to 4 inches), the existing customary and metric engineering standards showed 55 and 66 sizes, respectively. The existing standards also provided several thread types--usually one coarse and one to five fine--for each size. But the proposed system provided for only 25 sizes and one thread.

In January 1971 the Industrial Fasteners Institute presented its recommendations to 10 of the largest corporations in the United States, the National Bureau of Standards, and various groups in Canada. According to the Fasteners Institute, response was unanimous in favor of making a detailed study. It was decided that ANSI could provide a more proper forum to conduct the detailed study because the input would be broader based with users, Government agencies, and producers represented. In April 1971 ANSI formed the Special Study Committee to Develop an Optimum Fastener System.

The Special Committee was authorized to develop a total system of metric-threaded fasteners, taking advantage of opportunities (1) to improve fastener performance capability through product redesign and the most efficient use of materials and (2) to reduce the number of different sizes, series, grades, types, and styles of fasteners needed to satisfy the engineering requirements of the majority of industrial applications. The Committee's ultimate objective was to design a metric fastener system which would be so attractive technically and economically that it would become the single internationally accepted system of threaded fasteners.

The Special Committee performed the detailed study and in 1973 published its recommendations. The fastener system it recommended also had 25 sizes with one thread type. The Industrial Fasteners Institute used the Special Committee's recommendations as the basis for publishing its first metric fastener standard in 1974.

New U.S. system does not gain wide acceptance

A principal goal of the optimum metric fastener system studies was to provide a single-fastener system for the majority of industries to use which would be accepted internationally. But before ANSI's Special Committee finished its work, international resistance to the new system developed.

In November 1972, 5 months before the U.S. representatives formally presented their changes to the existing international standards, a paper was prepared by the International Organization for Standardization committee members from Britain and Germany entitled "Why Should the International Standards Organization System for Metric Fastener Threads be Changed?" The paper stated that the potential costs and confusion that would occur were unwarranted, the technical advantages were minimal, and the system could hardly be called "optimum." There were complaints of protectionism and everyone having to start all over again.

About the same time, the U.S. aerospace industry determined it could not use the new metric-threaded fastener system because it needed fine-threaded fasteners and some additional sizes. The aerospace industry has since developed its own system of metric fasteners.

From 1973 to mid-1977, negotiations continued within ISO. At the close of these negotiations, the U.S. representatives had essentially withdrawn their proposed changes to the international standard. The result is that the U.S. metric-threaded fastener standard will be essentially the same as the preferred series in the ISO standard, which contains 66 sizes in the 1-millimeter to 100-millimeter range--29 first choices, 15 second choices, and 22 third choices. The U.S. standard will list only 27 of the first choices. The international standard will still list several thread types for each size, one coarse and one to five fine. The U.S. standard will show only the coarse thread.

Strength grades and head size differences

The strength grades for fasteners in the 6- to 18-millimeter range proved to be a problem during the ISO negotiations. Fasteners in this size range are used extensively in automobiles and farm equipment. European practice has been to use international strength grade, 8.8, with a strength capacity of 116,000 pounds per square inch. The U.S. practice has been to use the Society of Automotive Engineers grade 5 with a strength of 120,000 pounds per square inch. The

U.S. representatives recommended adopting the next higher international grade, 9.8, with a strength of about 130,500 pounds per square inch to avoid downgrading U.S. practices.

According to an Industrial Fasteners Institute official, complete agreement was reached on strength grades at the meetings. This statement indicates that the European representatives had acquiesced to U.S. demands and agreed to use a higher strength grade fastener in their products. However, it appears that only the U.S. automotive industry will use the higher strength grade. The U. S. farm equipment industry and Canadian and European manufacturers will use the strength grade 8.8 for threaded fasteners. The Canadian Standards Association has cautioned Canadian fastener users that the higher strength grade, 9.8, may not be generally available in the reasonably near future outside North America.

U.S. manufacturers may face difficulty when their products are repaired overseas. For example, a grade 9.8 fastener could be interchanged with a 8.8-strength grade fastener. However, it is possible that failures could occur because of the insufficient strength, which could lead to liability problems, according to fastener experts. If fasteners in the strength grade 9.8 category are not available, fasteners in the next higher international strength grade--a 10.9 which requires an alloy steel--would have to be used as a replacement part.

A major problem arose during the attempt to reach agreement on the hexagon head size for three fasteners. This was probably the most hotly debated and difficult issue considered during the 1977 ISO meetings. The schedule below shows the head sizes wanted by the United States, those used in Europe, and those agreed to at the meetings.

Fastener sizes	Hexagon head sizes: Wanted by the U.S.	Used in Europe	Compromise sizes
(in millimeters)			
10	15	17	16
12	18	19	18
14	21	22	21

The Optimum Metric Fastener System study had shown that the head size for a number of fasteners was unnecessarily large. International standard sizes were widely used in Europe, but the European representatives had in 1975 agreed to reduce the head size 1 millimeter on each of the three sizes. The U.S. representatives agreed to the compromise

sizes in the earlier meetings, but in 1977 returned to the demand for a smaller head for the 10-millimeter fastener size.

The 10-millimeter size will be an important size in the automobile industry. The Industrial Fasteners Institute estimated that a 1-millimeter reduction in head size would save 9,000 tons of steel a year. At $350 a ton, this would result in annual savings of $3.15 million.

The European representatives would not approve inclusion of the 15-millimeter head in the international standard system, but they agreed to attach an appendix for explanatory and information purposes. The appendix stated that the 15-millimeter head would be phased out of production and use but, during an undefined transition period, its dimension would be provided in the appendix to assist designers and manufacturers and to assist in maintenance and repair requirements.

According to a U.S. fastener manufacturer, there is no provision to phase out the 15-millimeter head automatically, and European representatives will face an impossible task if they attempt to phase it out through formal actions in the near future. The official international standard will prescribe the head sizes for the 10-, 12-, and 14-millimeter fasteners as 16, 18, and 21 millimeters, respectively. U.S. industries will probably use these head sizes and the 15-millimeter size as well. European industries could continue using the old sizes, adopt the compromise sizes, or use a combination of the two.

Therefore, it is possible that several head sizes could be used for these three fastener sizes. Head sizes (like strength grades) are an example of an international standard which is formally agreed to on paper but not uniformly adhered to in practice.

The effect of the standardization efforts

U.S. industry officials believed the new metric fastener system they proposed was technologically better than the existing metric fastener system. However, international commercial considerations made it impossible for the proposed system to gain acceptance. The Europeans felt that the benefits to be derived from the new system did not justify the expense of making the changes.

According to an industry official, the affect of the international negotiations is that American National

Standards can be developed which are compatible with international standards. Standards writing committees working with ANSI have begun this work which may be completed by 1980. The Industrial Fasteners Institute will revise its 1974 metric standard, which was based on the Optimum Metric Fastener System study, to reflect the outcome of the international negotiations.

A fastener industry official stated that the use of these standards is voluntary. That is, U.S. industry does not have to use these standards. Fastener producers will make any type or style of metric fastener which U.S. industry requires, we were informed. However, the fastener industry would prefer that the new metric fastener standard be used because this is how the benefits of conversion--standardization and rationalization--in products will be realized.

The fastener industry anticipates that in the beginning of the conversion there would be an increase in the total number of different standard fasteners produced; an increase from about 500,000 to about 700,000 standard items. Eventually customary fasteners would be replaced by metric fasteners, according to a fastener industry spokesperson. The industry hopes that by the end of the conversion period, the total number of different standard fasteners produced would be about 300,000.

METRIC FASTENER DEMAND AND PRODUCTION

Estimating metric fastener needs is difficult, according to an official of a large U.S. fastener producer. The market has been very tentative. Except for the automotive market, there has been little demand for metric fasteners. Producers and customers interested in converting have awaited the outcome of international negotiations before producing and stocking the metric fasteners recommended by the Industrial Fasteners Institute.

Fastener producers said they generally did not have any major problems in making metric fasteners. Generally, metric tooling, such as drills, taps, rollers, and dies, are all that is required, and these are available. Since tooling components have a relatively short life, it is not difficult to phase in metric tooling.

Several producers told us that when making fasteners ordered in metric units, they converted the customer's engineering drawings into the equivalent customary units, made the items, and showed the metric units on shipping labels. Most fastener producers we contacted said they will make

any size fastener ordered--customary or metric--within the limits of their equipment as long as they can read the engineering drawing and make a profit on the sale.

Fastener producers are reluctant to stock metric fasteners unless demand is certain. An official of one company told us that he had stuck his neck out and stocked six metric sizes in 24 lengths. The stock included five lengths of the 6.3-millimeter fastener which was one of the U.S.-proposed sizes that did not gain international acceptance. This size was being used by a major automobile manufacturer in its 1977 and 1978 models. However, the automobile manufacturer has dropped it for future models.

MISMATCHING CUSTOMARY AND METPIC FASTENERS MAY CAUSE PROBLEMS

As manufacturers begin to convert from customary to metric fasteners, a number of problems are anticipated. The more serious problems are expected in the repair and maintenance areas, primarily because of identification problems leading to mismatching customary and metric fasteners. Identification problems are not new, and some steps have been suggested to overcome them.

As manufacturers convert, both customary and metric fasteners may be used in a product. It has been estimated that this mixture will continue for about 8 to 10 years for automobiles and farm and construction equipment.

Original equipment manufacturer's have few problems differentiating between customary and metric fasteners, but persons who repair equipment have more problems. Fastener installations by the original equipment manufacturers are done under relatively ideal conditions. However, when maintenance is performed, fasteners are often installed under conditions where they are not easily identifiable; and hand tools are less sophisticated, such as those used by an individual repairing an automobile at home.

Some steps have been suggested to overcome the identification problems, such as color dyeing the metric fastener, putting an "M" symbol on it, or placing a distinguishable mark on it showing its strength levels. Use of a distinguishable mark showing strength levels is probably better because the color dye is generally not distinguishable after use and an "M" could be confused with a manufacturer's trade symbol. Also, the head markings, which indicate strength, are different for customary and metric fasteners. For example, a customary fastener with a tensile strength of 120,000 pounds per square inch has 3 radial lines stamped

on its head, but a metric fastener with a tensile strength of 116,000 pounds per square inch is stamped 8.8.

It is virtually impossible to visually identify some sizes of customary-threaded fasteners from similar-size metric fasteners. It is possible to mismatch 36 combinations of customary- and metric-threaded fasteners. The result could be either stripping during assembly or full assembly with 25- to 60-percent loss in load capacity. Thus, the accidental mismatch of fasteners could result in fastener failures.

OVERALL CONVERSION COSTS ARE NOT KNOWN

An overall cost estimate was not available on what it would cost the fastener industry to metricate. We were told that the actual costs were proving to be much less than the originally anticipated figure of $2 billion. One major producer of automotive fasteners, however, estimated a 7- to 8-percent increase in costs due mainly to the need to increase inventories (customary and metric) and the shorter production runs which would result. Another estimated its cost to be $1.6 million over 5 years as follows: 60 percent for increases in inventory, 30 percent for nonconsumable tooling, and 10 percent for employee training. One user reported that metric fasteners cost an additional $8 per thousand fasteners.

There is general agreement that new production equipment will not have to be purchased for metrication of fasteners because the existing machinery can accommodate metric tooling. The tooling--customary or metric--which shapes the fasteners is part of the normal production costs because it wears out during production.

Some companies stated that metric conversion costs estimates are overstated and that actual costs of converting are much less than estimated costs. Others have stated that there should be no cost differential for metric products.

WILL CONVERSION MEAN MORE IMPORTS?

Imports of fasteners have increased significantly during recent years. In 1971 when the optimum metric fastener study began, the Department of Commerce estimated that with a conversion, imports could continue to increase. The industry, however, was more concerned that imports could increase dramatically if U.S. industry converted and they did not. Also, it was believed that imports would be less if U.S. industries adopted the proposed optimum system rather than the international system. In January 1977 imports accounted for about 17 percent of the total U.S. fastener market. For

nuts, bolts, and cap screws, imports amount to about 50 percent of the U.S. market. Fastener exports represent about 7 percent of production.

Industry officials hoped to reduce further losses of their markets, but some feared metrication and international use of the U.S. metric fastener standards will allow foreign manufacturers to further increase their sales in the United States. One manufacturer told us that instead of the foreign producers having to maintain dual inventories, the burden may have shifted to the United States.

Increased imports of fasteners may not be a concern to large industrial firms who use fasteners. We asked firms listed in the Fortune 500 Industrialists (see ch. 5) whether they would expect any change in the importation of fasteners and/or other components for their company's products if their companies converted to the metric system. About 83 percent of the respondents said they anticipated no change in imports if they converted. Also, of 17 motor vehicle industry respondents, 16, or 94 percent, replied that they expected no increase in imports if they converted.

CONCLUSIONS

The Fastener Industry's experiences show that increased standardization and rationalization benefits attributed to metrication are not easily attained. After 7 years of efforts, the industry was unable to convince U.S. industries and ISO members to accept the new U.S. metric fastener system. Therefore, U.S. representatives to ISO decided to adopt only a portion of the ISO metric fastener standard, and complete international standardization was not achieved.

It is too early to predict whether rationalization in fasteners will occur. The acceptance of the new system is voluntary and no industry is compelled to accept it. The proposed U.S. metric fastener system offers fewer sizes and thread types than the existing international metric standard, but it is the fastener users and not the producers who dictate the number of sizes and styles produced. Thus, if rationalization is to be achieved, fastener users will have to adhere to the proposed system.

The demand for metric fasteners is very tentative, with the automotive industry buying most of metric fasteners. Producing metric fasteners is not a major problem for the U.S. fastener industry. Generally, the industry anticipates some increased costs in conversion, but no overall cost estimate has been made. Identification and differentiation of certain metric and customary fasteners are likely to create problems

during repair and maintenance of products. But some solutions to these problems are being proposed.

RECOMMENDATION TO THE CHAIRMAN, U.S. METRIC BOARD

Under the current national policy, we recommend that U.S. industries interested in conversion be informed of the U.S. fastener industry's progress and problems in its attempts to achieve (1) adoption of its proposals for international standards and (2) increased standardization and rationalization.

CHAPTER 8

MACHINE TOOLS ARE ADAPTABLE

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We discussed metric conversion with industry associations and selected manufacturers. They indicated that it would entail some increased costs but would also produce some benefits. The change would not create much difficulty for the machine tool manufacturers nor for the machine users. Most existing machines, if not already modified, can usually be modified at relatively little cost to produce in either metric or customary units.

THE IMPORTANCE OF MACHINE TOOLS

Virtually every segment of the economy, particularly manufacturing, either uses machine tools or relies on some product(s) produced on a machine tool. The machine tool industry is considered a basic industry.

The National Machine Tool Builders' Association has defined a machine tool as

> "a power driven machine, not portable by hand, used to shape or form metal by cutting, impact, pressure, electrical techniques, or a combination of these processes."

Lathes, drill presses, and punch presses are examples of machine tools. Machine tools can range in size from a few feet to over 90 feet long. Prices will typically range from $10,000 to $3 to $4 million. Machine tools are produced in small lots of 5 to 100 at a time or, in many cases, are built on a special order basis (one of a kind).

Machine tools have a long design life; they tend to be revolutionary, not evolutionary, in design. Therefore, a design may be around for 20 to 30 years without undergoing major changes. The machine itself has a long life, up to 75 years in some cases. It is important then, that the parts used in the machine be standard-type parts that will be available for a long time. For example, the standards for metric fasteners have not yet been finalized in this country. If a manufacturer selects a metric fastener today, he may have to supply a part for the next 20 to 75 years that may not be in accordance with the accepted standards.

MACHINE TOOLS ARE ADAPTABLE

There is a distinction between a metric machine tool and a machine tool with metric capability. A machine tool with

metric capability can produce a product in metric units irrespective of whether its parts--screws, bolts, nuts, etc. --are metric or customary. Conversely, a metric machine tool is built with metric parts irrespective of whether its production capability is metric or customary.

If metric parts are to be used in manufacturing machine tools, it will usually be when a new machine is being developed. Changing existing designs from customary to metric is considered to be an unnecessary expense.

The users of machine tools are concerned about the impact conversion will have on their businesses. The National Tool, Die & Precision Machining Association--whose members use machine tools--has conducted two similar surveys concerning metrication. The first survey was conducted in 1974; the second, in 1977. The respondents' main concerns about metrication were employee training and machine tool conversions. The respondents were especially concerned about how a machine tool could be converted and what conversion would cost.

The options for converting machine tools from customary to metric capability or to dual capability can range from simply replacing the scales on the measuring devices to completely replacing the feed mechanisms and measuring devices. However, the latter case is rarely required. Many conversion kits are available for various machine tools. The key is that a machine tool is adaptable to produce in any measurement system.

The conversion process is commonly coupled with an overhaul or a general upgrading of the machine. When the machine is being overhauled, it is commonly upgraded by adding new features, one of which is numerical control.

Numerical control is the term used to describe a system which electronically controls a machine's feed mechanism and provides digital readouts. In recent years this feature has become more common on new machine tools. The conversion of numerically controlled machine tools to metric capability is simply a matter of changing the machine's programing. The newer numerically controlled machine tools generally have the necessary electronics built into them so that either customary or metric capability can be selected by flipping a switch to the desired mode.

Installing dual reading scales, gauges, and dials is less expensive than adding numerically controlled equipment. In most cases, installation is relatively simple and can be performed by the machinist or toolmaker. However, reading dual measuring devices tends to increase the potential for

error. Metric-only scales avoid this possibility, but their use is presently limited in this country because most orders for products produced on machine tools are in customary units.

The National Tool, Die & Precision Machining Association's 1974 survey results showed that the types of conversion options being used or anticipated by the respondents were in descending order:

Conversion options	Percent
Dual-reading dials, scales, and gauges	37
Digital readouts	31
Dual dimensioning on prints only	19
Metric-only dials, scales, and gauges	13

The Association's 1977 survey results showed that 51 percent of those responding have some of their machine tools equipped for metrics. Four percent have metric capability on all or most of their machine tools. When purchasing their most recent machine tools, nearly 40 percent of the respondents have been specifying metric capability, and 66 percent reported that future machine tool purchases will have full metric options.

THE MANUFACTURERS OF MACHINE TOOLS

The companies comprising the machine tool industry are mostly small businesses with sales in the $1 million to $10 million range. A machine tool company normally produces a narrow range of products, specializing in certain types of machine tools.

Metric activity

The status of metrication in the machine tool industry is mixed. Some companies are designing new products in hard metric; others are saying that metrication is not going to happen. For years the industry has been exporting machine tools that produce in metrics but are essentially customary in design and construction. Before the design and construction of machine tools with metric parts will occur, there will need to be more pressure from the industry's customers. According to officials of those companies making metric machines, they are not doing so because of immediate savings; they are converting because they view themselves as leaders in their industry. They intend to project that image by being one of the first to be involved with metrics. They also feel that conversion is inevitable, and consequently, any additional costs now will pay off in the long run by giving them a lead on their competitors.

Inventories

Because machine tool companies often supply repair parts to their customers over the life of a machine and some machines have lasted as long as 75 years, they will need a dual inventory for a long period if metrication occurs.

However, an official of one firm told us that as long as the entire industry converts at about the same time, dual inventories should not be a problem to a machine tool company from a cost standpoint. The additional costs would be a common phenomena throughout the industry and therefore could be passed on to the customer without the company losing its competitive advantage.

Training

Little employee training has occurred in the metric system, although many have been exposed to it. Training is not considered to be a difficult problem. Generally, it is agreed that some training is needed with attention given to teaching what the employee needs for use on the job.

Exports and imports

Converting to the metric system is not considered to have much effect on exports or imports. The governing factors for selecting a machine are such things as quality, price, and capability of the machine.

Advantages and disadvantages

Whether the advantages of conversion outweigh the costs for the industry cannot be readily determined. According to an Association official, the main advantages to metrication would be the elimination of fractions and the ease of communication. The elimination of fractions would be only a slight advantage because much of the industry already uses a decimalized inch. A company official told us that conversion would make it easier for companies to communicate with foreign customers about design features and/or engineering problems. The potential for uniformity throughout a company with overseas operations would provide it with greater design and production flexibility.

The disadvantage most frequently mentioned is the cost of conversion; however, we were not able to obtain any estimates of the industry's conversion costs. But, according to an Association official, if the conversion process is well thought out and conversion is made over a period of time, it will not be cost prohibitive to the machine tool industry.

TOOLING FOR MACHINE TOOLS

The tooling--drills, taps, reamers, milling cutters, abrasives, etc.--shapes the end products produced on a machine tool. A company official told us that obtaining tooling for metric operations should not be any more difficult than obtaining tooling required for customary operations and that costs of common metric items are now approaching those for comparable customary items. Because the tooling components have a relatively short life, it is not difficult to phase in metric tooling. Those who will be producing to both customary and metric specifications will find it necessary to have a method of identifying customary and metric tools.

Some metric tooling in this country, such as taps and drills, are not made completely metric because they would not be interchangeable in the customary chucks and holders used here. What counts is that the "working" part is metric; converting the machines to accept a "100 percent" metric tap or drill would be both expensive and needless at this time.

CONCLUSIONS

Machine tools can produce the same quality of products in either the customary or metric system. Most machine tools can be easily converted to produce in either customary or metric units irrespective of whether their parts are customary or metric. Therefore, the firms using machine tools should have little trouble in converting once their operators are trained and become familiar with the metric system.

Those who are designing machines with metric parts at this time appear to be doing so because they believe conversion is inevitable and they intend to be among the leaders in metrication.

To keep the economic impact to a minimum, the machine tool industry would prefer to convert to the production of metric designed machines over a relatively long period of time in accordance with normal replacement cycles. However, the industry is dependent on meeting its customers' demands and will convert over a shorter period if the demand is there, but at a greater cost.

CHAPTER 9

WEIGHING CONVERSION OF THE SCALE INDUSTRY

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Although the scale industry is relatively small, its products are highly visible and important in any attempt to change the system of weights and measures used in the United States. Probably no other equipment is used as broadly as scales; almost every product is weighed many times as it moves from the raw material state to finished form.

The scale manufacturers we contacted did not anticipate an increase in domestic sales or service as a result of metric conversion because they believed customary scales would be phased out through normal attrition or not at all under a voluntary program. U.S. conversion would have little, if any, effect on scale exports.

Adapting some customary scales in use to read in metric would not be difficult or expensive, but some costs and manpower would be involved. For other scales in use, conversion would be costly and, in some cases, not economically feasible.

The scale manufacturers did not consider manufacturing scales that read in metric but have customary-size parts to be a problem. Metrication of engineering and production equipment to produce scales with metric-size parts could be very expensive and would offer no benefits except for some possible standardization and reduction in the number of scale parts.

The manufacturers' customers would bear the costs of replacing customary with metric scales and converting scales in use without receiving any apparent benefits. The costs of metricating engineering and production equipment would also be passed on in the form of higher scale prices.

If a decision is made to convert scales, an effective conversion program for the millions of scales in use, particularly with respect to retail scales, would probably require some type of mandatory conversion with timetables. In the absence of such a requirement, retail scales may never be converted because retailers have no economic incentive to convert them. In the United Kingdom, Australia, and other countries that have been involved in conversion, it was necessary to require the conversion by enacting needed legislation. In some cases financial incentives were provided.

THE SCALE INDUSTRY

Millions of scales are used in the United States, such as in stores, factories, processing plants, transportation and storage facilities, farms, offices, and homes. The types of scales by function include household, baby, person weighing, postal, retail store, industrial, truck, etc. Many different scale designs are in use. They may be simple balance or sophisticated, automated, and electronic devices. In many industries and commercial enterprises, scales have become the means for automatic control of the processing and handling of materials and, in some cases, the means of controlling an automated factory. The most visible to the public are postal and retail store scales.

In 1975, there were 92 scale manufacturers employing about 6,500 people, of which 4,000 were production workers. The latest available estimate of industry sales was for 1975 when domestic sales were about $126 million and exports were about $11 million. Canada, which has no retail scale manufacturing industry, is the largest single importer of U.S. scales.

Metrication of scales would involve two levels of activity: the manufacturing level and the field or user level. Scales used in commerce to determine weights of items for sale are regulated by law. This frequently involves the inspection and testing of the devices as well as the quantities of the commodities. Metric conversion at both levels would be greatly affected by how government regulations are converted.

We discussed metrication with representatives of several small and large manufacturers and the Scale Manufacturers Association. We also discussed it with State weight and measure organizations, the National Conference on Weights and Measures, and large retail food stores. Discussions were held with the National Scale Men's Association, American National Metric Council's Weights and Measures Sector Committee, and Federal and Canadian officials. Pertinent documents were also reviewed.

In examining metrication of the scale industry, it is essential to make a distinction between producing scales that read in metric terms and metricating engineering and plant equipment for the design and production of scales with metric parts.

STATUS OF METRIC CONVERSION

None of the scale manufacturers we contacted had plans to convert to a predominant use of the metric system. Production of scales that read in metric and conversion of existing

scales will be undertaken when requested by customers. State weights and measures departments had no plans to change their laws and regulations to require the sole use of the metric system in commercial weighing. Their metric testing capability will be increased if a greater number of metric-reading scales are in use. Few customers of the scale industry have expressed an interest in buying metric scales or converting their existing scales.

Manufacturers

All the scale manufacturers had produced some metric-reading scales for the domestic market or export. Some scales have the capability to be read in both metric and customary. The design, engineering, and production of these scales, however, were performed in the customary system. Metric scales are generally used in scientific and research laboratories and to some extent in U.S. industry. Some physicians also use people-weighing scales that give weights in metric. One scale manufacturer was producing a "think metric" scale with a dial showing both the metric and customary weight. Customary scales, however, are predominantly in use in the United States.

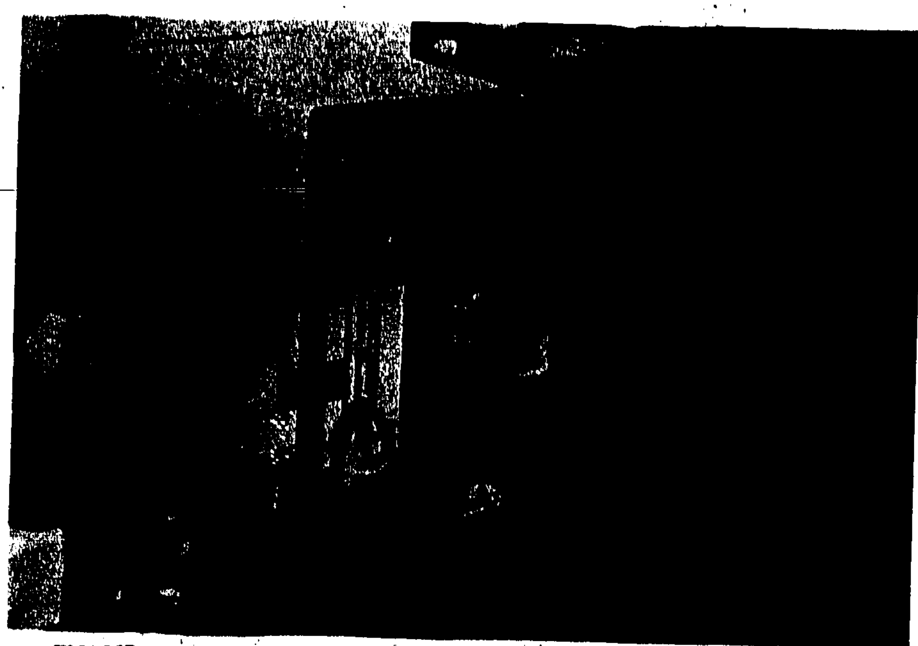
None of the firms we contacted had plans to convert to the metric system in terms of scale indicators or design. Representatives of a large multinational manufacturer said that the firm has a long-term commitment to convert its operations to metric, but any plans to metricate would have to be economically justified to the parent company. Some kits (parts, etc.) needed to convert scales to read in metric are available.

Industry associations

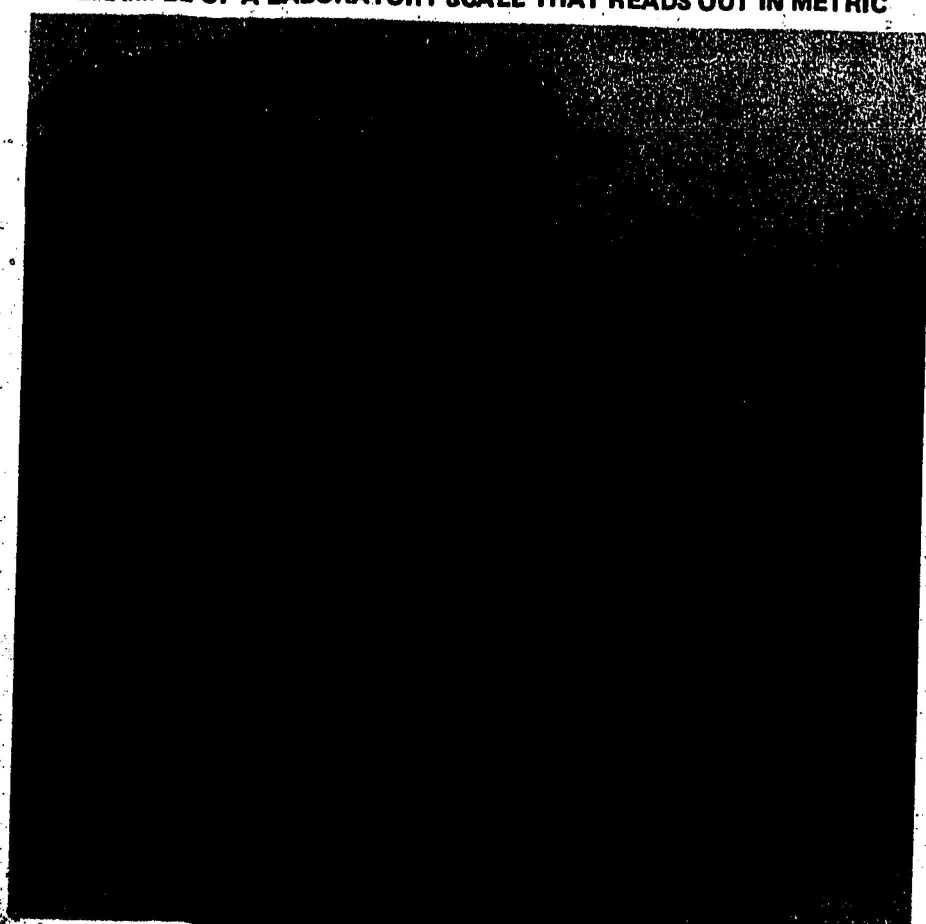
The Scale Manufacturers Association is a nonprofit organization established in 1945 to provide for coordinating the efforts of owners and users of scales and scale manufacturers. Twenty-two of the 92 scale manufacturers are members of the Association and account for about 75 percent of total industry production.

The Association provided data for the 1971 National Bureau of Standards metric study and had a metric committee until recently. It supports U.S. conversion, but, at the time of our study, was relatively inactive with regard to metrication. It was serving as the secretariat of the ANMC Weights and Measures Committee.

The National Scale Men's Association is a nonprofit organization of more than 1,300 manufacturers, dealers, users,



EXAMPLE OF A LABORATORY SCALE THAT READS OUT IN METRIC



EXAMPLE OF A SCALE WITH BOTH METRIC AND CUSTOMARY CAPABILITY
PHOTOGRAPHS COURTESY OF THE SCALE MANUFACTURERS ASSOCIATION

weights and measures officials, and suppliers of related components to the scale and weighing systems industry of the United States and Canada. The general objectives of the Association are to (1) promote the knowledge and application of scales and the legislation that will improve weighing practices and (2) set up performance standards for scale servicing, selling, and use.

The Scale Men's Association did not have a policy on metric conversion and had not undertaken any metric studies since its survey for the 1971 NBS metric study. It had been cooperating with ANMC in putting on a series of metric workshops, but these have not been very successful because there has been little interest among scalemen.

Laws and regulations

The regulation of scales used in commerce is generally a State and local government responsibility. The Federal Government provides the physical standards on which all weights and measures are based. The United States is the only technologically advanced Nation in the world with weights and measures regulatory programs legislated and administered at the State and local level. There are about 775 State and local jurisdictions that have regulatory authority for the enforcement of weights and measures laws and regulations.

In our questionnaire to State governments (see ch. 23), we asked whether the use of metric-reading scales for weighing consumer goods was legal in the States. Forty-two States responded as follows:

Yes, with no restrictions	26
Yes, after obtaining State authorization	4
Yes, with certain restrictions	1
No	11
Total	42

Thus, scale conversion would require changes in the laws of at least 11 States. In addition, the technical specifications and tolerances governing scales in all States are generally expressed in customary terms. Although this alone does not preclude the use of metric-reading scales, it makes it more difficult, and it is understood that the laws and regulations

of all the States would have to be converted if metrication is to take place.

One State was in the last stages of developing a metric code for regulating scales. The new metric code would be used simultaneously with the customary code until customary-reading scales are phased out. Nearly all the other States are waiting for development and approval by the National Conference on Weights and Measures of a metric Handbook 44. The National Conference's Handbook 44, "Specifications, Tolerances, and Other Technical Requirements for Commercial Weighing and Measuring Devices," is a voluntary model code that is used widely by the States in the formulation of their own codes.

The National Conference on Weights and Measures is an organization of State and local weights and measures officials formed in 1905 to develop model weights and measures laws and regulations, of which Handbook 44 is one. It is sponsored by the NBS Office of Weights and Measures which acts as secretariat.

The National Conference created a Metric Planning Committee in 1973 to assist State and local officials and industry representatives. The purpose of the Committee was to develop guidelines for the proper use of the International System of Units in the marketplace. Standing committees of the conference were asked to review their publications for the purpose of eliminating any obstacles to use of the metric system. These publications include model State laws, regulations, and handbooks governing weights and measures devices and practices, and have been or are being revised to provide for the use of metric measurements and to set forth requirements if the metric system is used. The most important of these to the scale manufacturers and weighing regulatory officials, Handbook 44, has not been metricated.

The National Conference had called for the development of a hard conversion of Handbook 44 to be completed by 1979, but later decided to drop the target date for its completion. An official told us that the date was unrealistic and had been adopted [illegible] to effect a serious attitude toward metrication to the scale industry and State and local weights and measures officials. The NBS Office of Weights and Measures is working on conversion of the handbook to remove restraints on the use of metric units. Office of Weights and Measures officials anticipated that an approved metric Handbook 44 would be used concurrently with the present customary edition for some time. The National Conference has not made a decision on whether the metric handbook would be a separate document or combined with the customary edition.

Metrication of scales used in commerce would also require that State and local government weights and measures officials have the training and equipment to test and approve metric-reading scales. In 1965 the Congress appropriated funds for new State weights and measures standards. The States were provided with new sets of standards and laboratory instruments, both customary and metric. Although the States may have adequate metric capability in their laboratories, the capability (expertise and equipment) for field testing of scales varied widely. One State official told us that the State has full field testing capability. An official of another State indicated that the State had no metric field testing capability and no current need. Because few metric-reading scales were in use, the States generally did not need metric capability.

THE SCALE INDUSTRY ANTICIPATES NEITHER AN INCREASE IN DOMESTIC SALES NOR EXPORTS AS A RESULT OF METRIC CONVERSION

The possibility that the scale industry would benefit from metric conversion due to a resultant increase in sales and service was disputed by industry representatives. The industry probably would increase domestic sales if conversion of scales is made mandatory within a short transition period. Otherwise, metric scales, if purchased, would be purchased as old customary scales are normally replaced, and conversion kits and services to adapt existing scales would not be needed. Electronic computing scales that have dual capability or are rather easily converted are coming into greater use. They are expected to be prevalent within the next 10 years.

Although scale manufacturers generally considered metric conversion to be inevitable, spokespersons for two of the largest manufacturers told us that conversion is not imminent, and retail food scales may never be voluntarily converted to metric because retailers have no economic incentive and thus little interest in converting them. It is possible that retail scales will be designed in metric and built with metric parts but read in customary weight.

In Canada weights and measures laws, which are under the authority of the Canadian Government, will be changed to require conversion. The conversion of retail food scales will be subject to special tax measures which will relieve some of the financial burden on the retail food industry. The import duty and Federal sales taxes on conversion kit parts will be exempted. For income tax purposes, the conversion costs can be expensed in the year they are incurred.

New metric retail food scales to replace existing customary scales are subject to half the normal Federal sales tax rate and can be written off in the year they are purchased. Canada had no experience with this program at the time of our study because the conversion program for scales had not begun.

The scale manufacturers anticipated no increase in their exports because of U.S. conversion. The system of measurement has little, if any, impact on exports except that the scale must usually read in the measurement system of the importing country. Customary scale parts and fasteners are neither a restriction on sales abroad nor a problem to foreign customers because maintenance and service are usually performed by the manufacturer. A change in the readout is a minor adjustment. Quality, price, and trade barriers, such as import tariffs, were the important factors in international trade of scales. Metric countries export scales that read in customary to the United States.

Except for the readouts, scales produced for foreign markets, with the exception of those for West Germany, are the same as those produced for the U.S. market. West Germany has certain design requirements that make it necessary to produce different scales. According to industry representatives, these standards can easily be met. The real problem involves their lengthy prototype approval system.

METRIC CONVERSION AT THE MANUFACTURING LEVEL

Metric conversion at the manufacturing level involves two distinct degrees of activity. The first and simplest is the production of scales that read in the metric system. The second is the metrication of engineering and plant equipment to produce metric-size scale parts.

The scale manufacturers did not consider producing scales with metric indicators to be much of a problem; however, some costs would be involved. They already have produced some scales that read in metric, primarily for export. It may be necessary, however, to redesign the weighing elements, such as levers, springs, and load cells, in some types of scales. The computing scales for retail food and postal weighing may also require some redesign. Such problems are expected to decrease because the trend in the industry is to manufacture electronic digital scales. Many of these will probably have dual (both customary and metric) capability. However, the full impact of producing metric-reading scales will not be known until the State and local government laws and regulations governing commercial weighing are metricated. During a

transition period, there may be a problem with dual inventories of weight indicators.

Changing plant equipment to produce metric-size scale parts could be costly. A representative of a small scale manufacturer estimated that such a conversion would cost at least $500,000 and would force the firm out of business. A representative of a large manufacturer said his firm could absorb the costs if carried out over a 15- to 20-year period. Maintaining dual inventories of scale parts and design drawings would be another cost. Parts and drawings are generally maintained for 15 years after production. Some costs would be incurred by changing internal operations, such as ordering accounting, and administration. Technical publications and advertising material also would be affected. Some training of personnel would be required.

Few benefits were anticipated from metrication of engineering and production equipment. Some standardization and the reduction in the number of scale parts may result. This would be advantageous to the industry and its customers.

METRIC CONVERSION AT THE USER LEVEL

Conversion of scales at the user level could involve one of two basic approaches. The first would be a phase-in of metric-reading scales as customary scales wear out, become obsolete, or the owner wishes to upgrade scale capability. The second approach would be to force adaption of scales in use to read in metric, or, if not feasible, to replace them with metric scales. All future scales would be those reading in metric. (If scale conversion takes place, consumer scales, such as bathroom scales, in use probably would not be adapted to metric but would be replaced with metric scales when they wear out or the owner wishes to purchase a new scale.)

The major drawbacks of the first approach would be that complete conversion could take many years and both customary- and metric-reading scales may exist side by side. This could lead to confusion in the marketplace. Consumers may avoid purchases at retail stores that have metric-reading scales and thus give the competitive advantage to those who do not convert. This approach, however, would be significantly less expensive because existing scales would be replaced through normal attrition rather than adapted or replaced before they normally would.

The second approach would be much more costly and have a shorter transition period but would be more orderly. Although some scales are not difficult or costly to convert, some costs would be involved. For others, adapting to read

in metric would be costly; and in some cases, conversion would not be economically feasible, and the scales would have to be replaced. This approach would most likely have to be made mandatory to be effective because there would probably be no economic incentive for scale owners to convert. All retail scales, at least in an advertising area, should probably convert at the same time. This would be necessary to avoid giving retailers that do not convert a competitive advantage over others that do.

In developing a scale conversion plan, decisions would be needed on the necessity for metrication of engineering and plant facilities and how industrial scales should be treated. Owners and users of scales probably would neither be aware of nor have any interest in whether scale parts are designed and produced in metric or customary unless the cost increased as a result. The important characteristic would be whether the scales give weights in customary or metric.

Consideration should be given to whether industrial scales in manufacturing plants should be included in a conversion schedule for other scales or in a schedule for the industries which use them. These scales are not visible to the public as postal and retail store scales are.

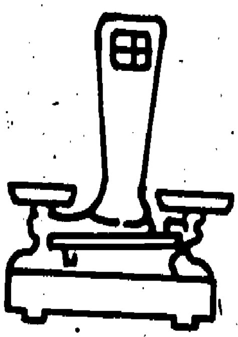
Adaption of existing scales

The cost of adapting existing scales would not be known until the technical requirements (including code requirements) and the period over which scales are to be adapted are decided. No one has determined the number of scales that would be involved because no decision had been made to convert existing scales. It is a voluntary conversion. Some in the industry have estimated that there may be 5 million or more scales in use in the United States, excluding bathroom and household scales. The population and its makeup may change before conversion occurs. For example, the use of electronic computing scales is increasing rapidly.

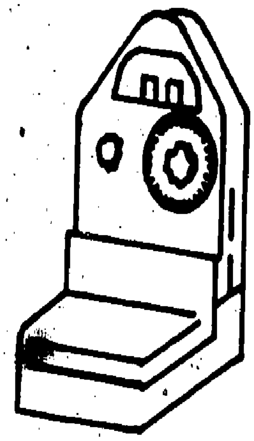
A March 1974 Canadian task force study report, "The Metric Conversion of Weighing and Measuring Devices in Canada," estimated that Canada had 116,800 retail food store scales; 50,310 postal scales, of which 31,200 were privately owned; and 179,300 industrial scales--a total of 346,410 scales. It was estimated that 244,800 of these would be converted at a cost in the range of from $60 million to $115 million (Canadian dollars). Complete cost estimates to replace the remaining 101,610 scales were not provided.

A decision by a scale owner to adapt or replace a scale would probably be based on factors such as the type of scale,

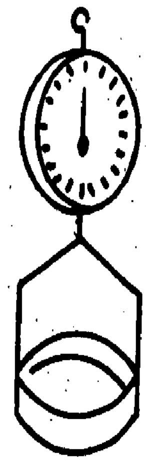
EXAMPLES OF COMMON RETAIL SCALES



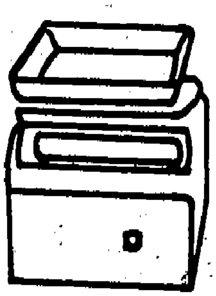
EVEN BALANCE SCALE



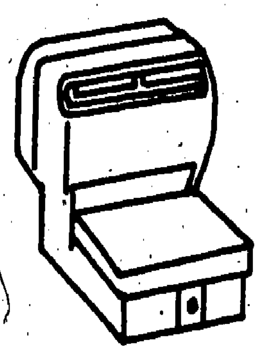
PROJECTION SCALE



DIAL SCALE



CYLINDER SCALE



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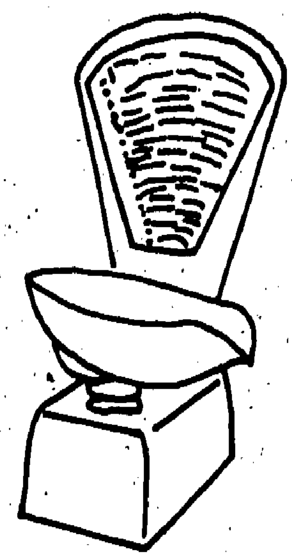
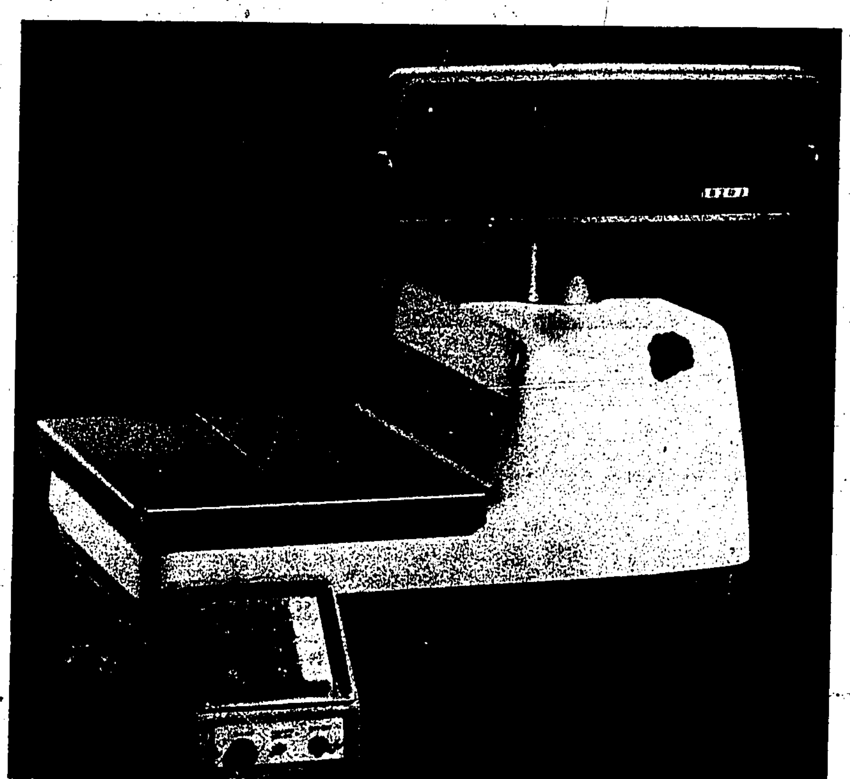
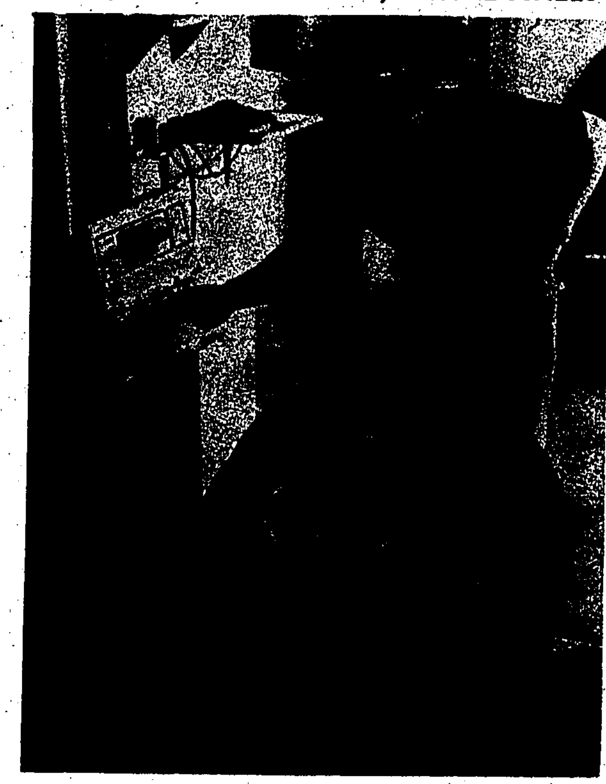


FAN SCALE

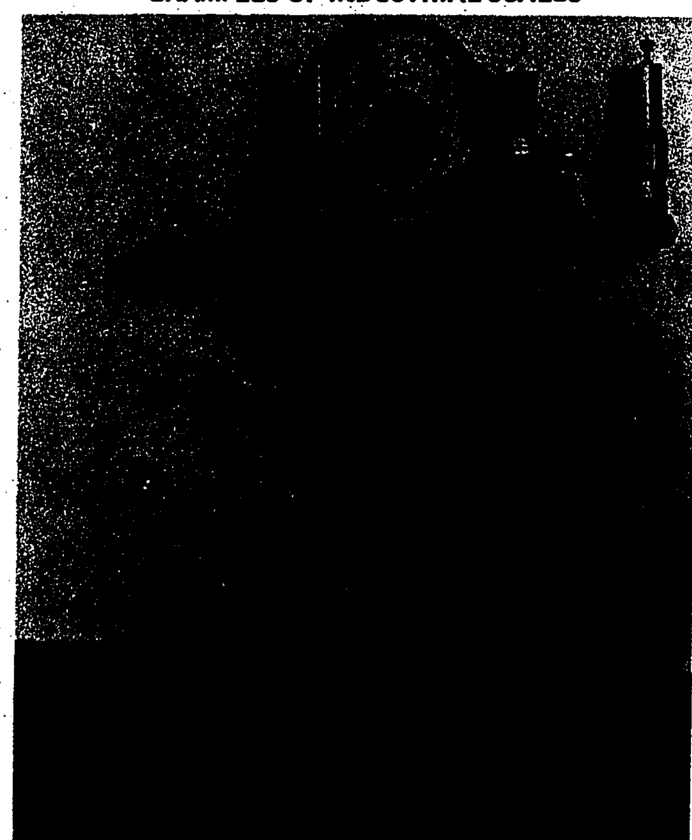


EXAMPLES OF ELECTRONIC, DIGITAL SCALES



PHOTOGRAPHS COURTESY OF THE SCALE MANUFACTUERES ASSOCIATION

EXAMPLES OF INDUSTRIAL SCALES



PHOTOGRAPHS COURTESY OF THE SCALE MANUFACTURERS ASSOCIATION

the conversion cost, the age of the scale, availability of parts, the cost of a new scale, and the need to upgrade scale capability. A representative of a large scale manufacturer said that only a small percentage of the scales the firm produces is readily convertible, but that within 10 years, many of these scales would probably be made obsolete by electronic digital scales. These would probably have dual capability or be readily adapted.

Australian officials reported that during scale conversion many retail scales were replaced with electronic digital scales rather than converted. The officials believed that these speed up the weighing and pricing operation and reduce errors. Canadian officials also anticipate the purchase of many electronic digital scales during their planned conversion.

Another consideration in the adaption of existing scales is the service personnel and time required. The Canadian task force estimated that if retail scales were converted within a 2-year period, it would require an increase of about 16 to 20 percent in the retail store scale technician work force, or an equivalent in overtime. If industrial scales were converted in 6 years, the number of technicians would have to be increased to 25 to 30 percent with some overtime. U.S. scale manufacturers expressed concern that not enough trained service personnel would be available for a quick conversion of existing scales.

In Canada it was decided that existing scales should be adapted to metric within a short transition period. The conversion program for postal and retail scales is scheduled to start in July 1979 and is to be essentially completed by the end of 1981.

Conversion of Canadian retail food scales is to be tested in three metropolitan areas. In order that no retail store will lose business to a store that does not convert, all retail store scales within the advertising area of each city will be converted. After these three areas are converted, other areas will be included in the conversion plan. Conversion will be mandatory through changes in the weights and measures laws, which are administered by the Federal Government. Industrial scales will be converted when the industries that use them convert.

Impact on State and local regulatory officials

State and local regulatory officials would be responsible for metricating the codes that regulate commercial weighing. In addition, conversion would probably pose other problems.

Field testing equipment would have to be adapted to metric units, where possible, or new metric equipment would have to be purchased. Estimates of the cost of a set of metric test weights were from $300 to $450. The number of test-weight sets that would have to be converted or replaced was not known. A 1974 NBS survey found that there were about 3,000 weights and measures inspectors in the United States. Not all of these were involved in testing scales. Not every inspector responsible for testing scales would need a complete set of test weights because some inspectors test only certain types of scales. Converted scales and new metric scales would have to be tested by an inspector. Under a quick conversion program, additional staff may have to be employed. Metric training for personnel also would be needed.

The NBS Office of Weights and Measures historically has assisted regulatory officials in the areas of field personnel training and development of model codes. The Office has provided metric training seminars to regulatory officials using funds from a $35,000 Office of Education metric education grant. The Office is also working on a metric Handbook 44. The Director of the Office of Weights and Measures said that the Office would need more funds and staff to carry out the activities to prepare State and local weights and measures officials for metric conversion.

U.S. PARTICIPATION IN THE INTERNATIONAL ORGANIZATION OF LEGAL METROLOGY: A METRIC CONVERSION ISSUE?

The International Organization of Legal Metrology is an intergovernmental treaty organization founded in 1955 to establish uniform requirements for various types of weighing and measuring devices, including cooperation in the field of legal metrology, which relates, broadly, to the laws and regulations and their enforcement. This international organization has similar objectives to the National Conference on Weights and Measures but on an international level.

In carrying out its objectives, it serves as a center of documentation and information. It also recommends uniform international requirements for scientific and measuring instruments, such as scales, used in industry and commerce and develops model laws and regulations for consideration by member nations. In 1972 the United States became a member with participation being coordinated through NBS.

Industry representatives told us the primary benefit of participation has been as a source of information; however, State Department Officials have said that the United States

has a moral commitment to consider international recommendations of the organization.

Industry representatives believed that before the United States decides to adopt any recommendations, it should have a significant input. The first year for possible significant U.S. input will be the next meeting in 1980. Industry officials indicated that U.S. input is needed because the organization has been dominated by European thoughts on scale design and regulation which is different.

Metrication of scales should not take place before U.S. input and a decision is made on whether the organization's recommendations are to be adopted in the United States. If metrication and adoption of the recommendations are not made simultaneously, the industry might have to go through two significant changes. An NBS official told us that U.S. involvement in the International Organization of Legal Metrology is independent of domestic metrication of scales and would continue even if the United States does not convert to the metric system.

CONCLUSIONS

Conversion to a predominant use of metric scales will probably not occur unless it is made mandatory. Otherwise, conversion of industrial scales will depend on whether industries that use them decide to convert their internal operations. Retail scales may not be converted voluntarily because retailers have no economic incentive to convert.

Substantial costs could be involved to convert scales in use. The alternative would be to phase out customary scales through normal attrition and replace them with metric scales. This approach may be practical for industrial scales but not for retail scales. The use of both metric and customary retail scales would cause confusion in the marketplace. Consumers may avoid retail stores that have metric scales. This would give a competitive advantage to retailers that do not convert. State and local weights and measures officials would also face costs for metric training and metric test weight sets.

Scale manufacturers did not anticipate any major problem in producing scales that read in metric but have customary-size parts. Metrication of engineering and production equipment to produce scales with metric-size parts, however, could be expensive.

U.S. conversion was not expected to increase scale exports. Domestic sales would be increased only if conversion

were made mandatory with a short transition period. An increase in production of metric scales will depend on demand by the industry's customers.

To have an effective conversion program, particularly with respect to retail scales, some type of mandatory conversion with timetables would probably be required. Industrial scales could be converted as the internal operations of the industries that use them are converted. Retail scales, at least within an advertising area, would probably have to be converted at the same time to avoid giving a competitive edge to those that otherwise would not convert. A major determining factor in the success of retail scale conversion would be consumer acceptance of the metric system.

CHAPTER 10

TRANSPORTATION--OVER THE MILES TO METRIC

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Changing the measurement system used in transportation will have far-reaching effects. It will affect the design and manufacture of motor vehicles, trains, aircraft, and ships; the legal control systems (speed limits, load limits, assigned routes, safety limitations, etc.) that govern their use; and the computation of rates charged for their use (fees for shipping goods and transporting passengers). Effects will be minor and almost unnoticed in some cases, but in other cases will have important economic and social implications on manufacturers, operators, legislators, law enforcers, shippers, and the general public. The Department of Transportation's policy is to pursue and promote an orderly changeover to the metric system. The policy allows for industry to set the pace for changeover, but the Department may, when it has statutory authority, initiate some changes. (Because of its unique worldwide application, air transportation is discussed in ch. 15 with the aerospace industry.)

We talked to Federal and State transportation officials, representatives of transportation associations, operators of transportation companies, State legislators, and enforcement officials. Most felt that conversion may benefit some parts of the economy but that it was not cost beneficial to transportation.

Highway users felt that equipment conversion would not result in real benefits and would be very expensive. For example, the two most prominent measurement items on a truck are the speedometer and odometer. Specialists estimate that it would cost from $40 to $75 for a speedometer conversion and possibly over $100 for an odometer conversion, depending on the model. With 26.5 million trucks in operation in 1976, this would be very expensive.

The National Highway Traffic Safety Administration issued a regulation in March 1978 requiring that all motor vehicles manufactured after August 31, 1979, be equipped with speedometers that register in both miles per hour and kilometers per hour. Affected parties were not provided an opportunity to comment on this new regulation which was issued on the agency's own initiative. We do not know the extent of the impact on motor vehicle manufacturers.

Of course, there are kits and decals available for passenger cars which would reduce the cost for the speedometer conversion. These may or may not be appropriate for motor freight carriers. At this time there does not appear to be a

similar solution for the odometer problem. Both instruments, but particularly the odometer, are important in determining the costs of transporting goods and people. Metrication may be justified if it would result in improvement of the system or higher profits, but this is not the case.

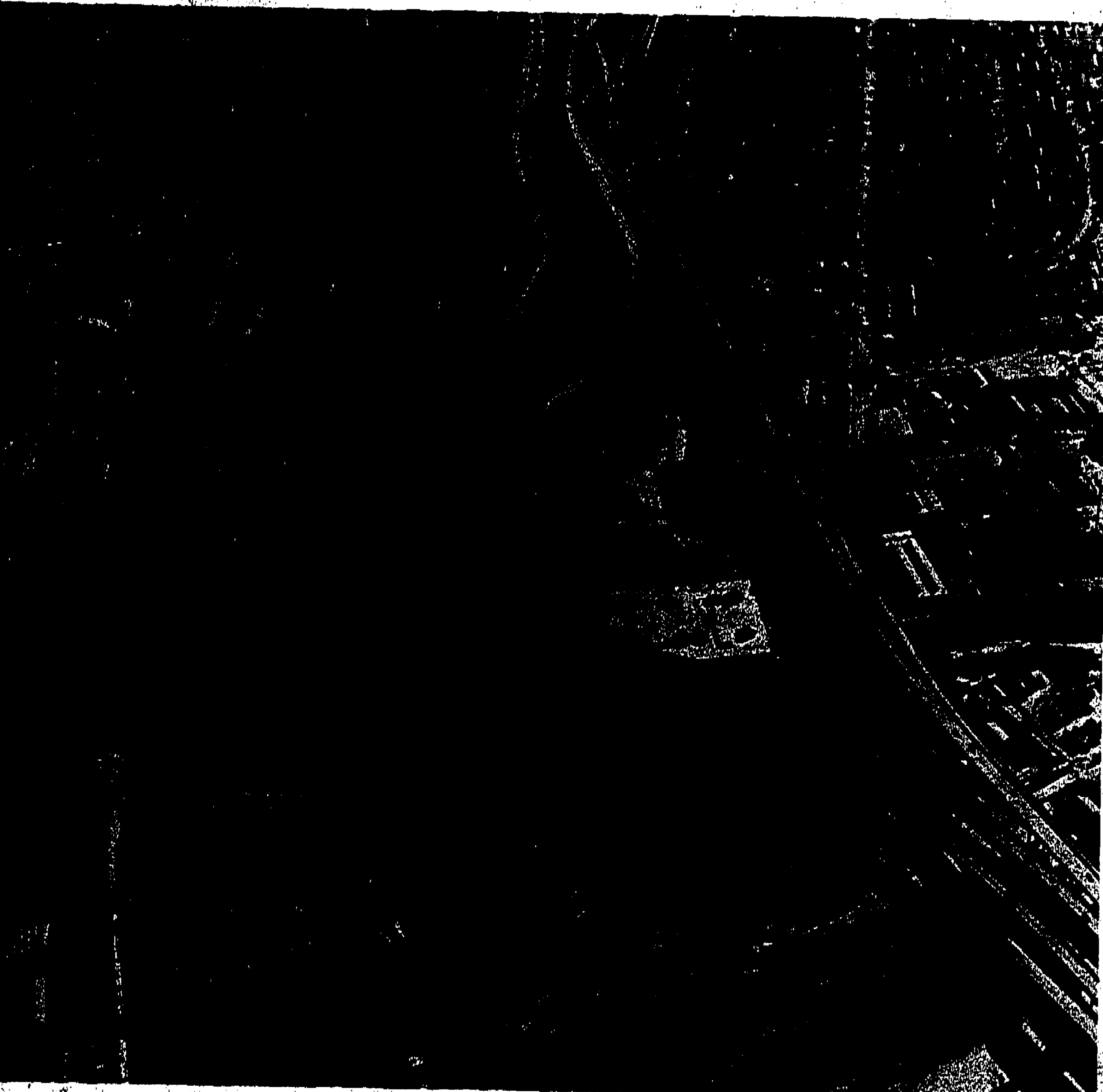
Railroad officials think it is folly to assume that the railroad companies, with their tremendous investment in railroad cars, track, and terminals, could convert. They emphasized that most of their fixed and movable equipment has a long life and could not be economically replaced with metric equipment for a long time. Some things would never be converted to metric sizes but only could be called by a metric equivalent of its present size. For example, we should never expect the distance between rails of track to change from its present 4 feet 8-1/2 inches, although it could be called 1,435 centimeters or 1.4351 meters. Tariffs (the schedules of rates and charges for transportation of freight) would be difficult to change and have few benefits.

Maritime transportation has a conversion plan developed by the Maritime Transportation Research Board of the National Academy of Sciences. However, the plan suggests a schedule for national maritime conversion without asking "Why should the Nation go metric?" There was no consideration of the benefits or costs to the industry, only emphasis of the need to plan for "orderly conversion." The maritime plan seems to simply commit the industry to metrication because national metrication seems to be "inevitable."

Implementation depends largely on the industries that supply components for shipbuilding. These industries may or may not have their own conversion plans. However, the U.S. shipbuilding industry is too small to influence suppliers who do not have plans to convert. The maritime industry also has much equipment with a long life which will not wear out for many years and would be uneconomical to replace before necessary. This, as in railroads, will delay the conversion time.

Some groups of shipping lines, however, have already metricated rates for shipping weights and volumes of cargo to foreign ports.

The attitude toward changing systems of control and regulation of highway traffic was made clear in June 1977 when the Federal Highway Administration's proposal to convert speed limits and other highway information and advice signs was soundly objected to by about 98 percent of the more than 5,000 who commented on the proposal. The proposed regulations would affect not only commercial transportation interests, but the millions of motorists who would have to drive by the regulations,



METRICATION OF HIGHWAY AND STREET SIGNS WOULD AFFECT MILLIONS OF MOTORISTS.

PHOTO COURTESY OF THE FEDERAL HIGHWAY ADMINISTRATION.

the States which would have to amend their laws and replace old signs with new metric ones, and law enforcement agencies throughout the country that would have to enforce compliance.

Opposition was mainly based on the $100 million cost for changing signs, the confusion it would cause among drivers, the time needed for States to amend traffic laws, and the difficulties of enforcing the laws among unprepared drivers. Also, opponents raised a very basic question of whether the Highway Administration had the authority to make such a change. (We also believe that the Highway Administration's authority to mandate road sign conversion is questionable.) The Federal Highway Administration terminated its proposal to change the regulations in the face of this opposition.

We feel that the metric conversion of transportation will be slow. It is highly dependent on the conversion of industry. Except for automobiles which have a relatively short life, transportation equipment has a long life. For example, in its publication, "Motor Vehicle Facts and Figures 1977," the Motor Vehicle Manufacturers Association showed that in 1976, 9.3 percent of the 26,560,000 trucks in use were 16 or more years old. By contrast, only 2 percent of the 97,790,000 automobiles in use were as old. The Association of American Railroads reported that freight cars are often in use for 30 years; locomotives, for 20 years. Ships have a minimum expected useful life of 25 years. We expect a long period when both customary and metric will be in use.

We can see no advantages in changing highway signs to metric. Conversion of highway signs may come only when the Congress declares that the Nation will adopt the metric system, States are able to afford the change or Federal aid is made available, automobiles are equipped with metric speedometers and odometers, and the driving public is oriented to the safe use of metric measurement.

Transportation tariffs and rates will be changed as needed. This aspect of the conversion will be complex and expensive.

DEPARTMENT OF TRANSPORTATION POLICY

The Department of Transportation was established in 1966

"to assure the coordinated effective administration of the transportation programs of the Federal Government" and to develop "national transportation policies and programs conducive to the provisions of fast, safe, efficient, and convenient transportation at the lowest cost consistent therewith."

The Department includes the Federal Highway Administration, the Urban Mass Transportation Administration, the National Highway Traffic Safety Administration, the Federal Railroad Administration, the Coast Guard, the St. Lawrence Seaway Development Corporation, and the Federal Aviation Administration as operating elements.

The Department's metrication policy, announced in July 1977, establishes departmental policy and administrative procedures for orderly transition to the metric system. Its policy is to pursue and promote an orderly changeover to the metric system. The policy will allow industry to set the pace for changeover, but the Department may, where it has statutory authority, initiate some changes. When the Department initiates change, it will be done in ways that will minimize costs to industry caused by the change. Most changes will involve new systems and facilities rather than redesign of existing ones.

Each operating element in the Department is to (1) develop guidelines and standards for conversion of its area of responsibility, (2) make the guidelines and standards available to industry, and (3) consider the plan and the metric system in the procurement of all equipment, services, and supplies, especially in the design of new transportation systems. These plans will be reviewed and consolidated into an overall transition plan by the Department's Metric Coordination Committee.

The policy order also requires each operating element to be responsible for training its personnel in the use and application of metric units. Costs necessary to support the Department's conversion effort will be identified so that funds can be included in succeeding budget cycles.

HIGHWAY MILES TO KILOMETERS

In February 1974, before establishment of the Department of Transportation's conversion policy, its Federal Highway Administration organized a Coordinating Task Force on Metrication to plan for changeover, prepare engineers and other employees for conversion, and keep in touch with metric activities. Within the same year the Highway Administration awarded a research contract to the Ohio Department of Transportation to document its experience in completing two metric highway projects. It also established a policy requiring use of metric equivalents for all measures in Highway Administration technical publications, reports, and specifications; and issued a directive giving States permission to install metric familiarization signs on interstate and other highways built with Federal aid. The Highway Administration's latest

conversion activity was its publication, in April 1977, of its intention to require speed limit and other highway signs to change to metric by 1982.

Metrication of standards for traffic control devices

In May 1976, in response to a request from its Advisory Committee, the Highway Administration assigned its Office of Traffic Operations to revise the Manual on Uniform Traffic Devices, with the objective of issuing a new edition within 2 years, containing only metric units of measurement and rational metric standards. The manual, which contains principles for the design and use of all highway and street traffic controls such as signs, signals, and road markings, is regarded by the Highway Administration as the national standard. Although most States have adopted the Manual, its use is not mandatory except on the Federal-aid highway system.

A timetable for conversion of highway signs

The Highway Administration thought that setting up a schedule for the conversion of traffic signs on highways and streets would be a good way to influence metric conversion. The States and their subdivisions, they said, were required by law (U.S. Code title 23, sections 109(b) and (d), and 402(a)) to comply with the Manual of Uniform Traffic Control Devices on Federal-aid highways. Because the Manual was being converted, the timetable would make the conversion of signs an orderly process. An official told us that Federal highway funds could be withheld from a State which did not comply with the following timetable.

Recommended Timetable for Planning Metric Conversion of U.S. Traffic Signs

Accomplishment	Due for completion
Develop conversion guidelines	1976
Develop metric sign drawings	1977
Publish metric Manual of Uniform Traffic Control Devices	
Public information program	1978
Revision of pertinent laws and regulations	1978

Begin speed sign conversion (includes advisory speed plates and vertical clearance warning signs)	July 1, 1978
Reach 50 percent compliance	July 1, 1979
Reach 100 percent compliance	Dec. 30, 1979
Warning and regulatory signs	Sept. 30, 1980
Guide signs, mileposts, and other advisory signs	Sept. 30, 1982

The public is notified

In the April 27, 1977, "Federal Register," the Highway Administration published an advance notice of its intention to change the regulations and solicit comments on its timetable for conversion of highway traffic signs to the metric system. The notice also advised the public that the Highway Administration is revising the Manual of Uniform Traffic Control Devices to establish metric standards. Comments on this notice were to be received in 45 days (by June 13, 1977). It quoted section 3 of the Metric Conversion Act of 1975 as authority for the action.

> "Sec. 3 It is therefore declared that the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

The "Federal Register" notice contained an unexpected revision to the timetable for conversion of speed limit signs that was contained in an April 26 press release. The 90-day period, recommended until just before publication of the notice, was extended to 18 months. The revisions proposed that the change of speed limit signs and vertical clearance signs would begin on July 1, 1978, reach 50 percent compliance by July 1, 1979, and 100 percent compliance by December 30, 1979, "to minimize driver confusion and facilitate law enforcement efforts."

The notice stated that many signs may be converted by the use of overlays or simple letter and number changes, but in some instances, new signs may be necessary.

A rough cost estimate

At its June 1976 meeting in Kansas City, Missouri, the American Association of State Highway and Traffic Officials had estimated that changing the approximately 3,489,800 traffic signs on highways and streets in the United States would cost about $110 million. They admitted that the cost estimate was very rough because neither (1) the number of signs nor (2) the method of conversion that would be used by all the States (decals, changing only some numbers, completely new signs) was known. (Exact costs would be determined by the method of conversion.) The Highway Administration did not make a cost study of its own before publication of its plan, but apparently, it used the above figure as a general estimate of what the job would cost.

The Congress, organizations, and the public react

On April 28, 1977, the day after the Highway Administration's notice in the "Federal Register," a bill was introduced in the Congress to prohibit the expenditures of Federal funds to modify highway signs for metric conversion unless specifically authorized by the Congress.

On June 1, 1977, a member of the Congress sent a letter to the Highway Administrator requesting immediate withdrawal of the notice of proposed rulemaking and the cancellation of all plans to force metric conversion on American motorists. The letter pointed out that (1) the Metric Conversion Act did not grant the Highway Administration authority to propose rules, (2) the Congress has not established an official policy of conversion, (3) the Congress expected metric highway signs to be a complement rather than a substitute for customary signs, (4) the act stressed voluntary conversion, (5) the act was not to be used to force costs on anyone, and (6) by proceeding without the guidance of the Metric Board, the Highway Administration would be contributing to haphazard conversion. Other members of the Congress also wrote letters of opposition to the Highway Administration.

By June 13, 1977, more than 5,000 comments on the proposal had been received. Letters were sent by State and local transportation authorities, motor clubs, consumer organizations, farm bureaus, manufacturers, State and local public works departments, many other organizations, and private citizens. Ninety-eight percent of the comments were negative.

A Highway Administration official said that the more than 5,000 letters was higher than for any other rulemaking the agency had ever proposed. The highest before this was

under 500. We read about 400 of the letters and found that they were overwhelmingly against metrication of signs.

In light of such overwhelming opposition, the Highway Administration published a notice which terminated the proposal in the June 23, 1977, "Federal Register." Also, a Highway Administration official told us that the Manual of Uniform Traffic Control Devices will not be changed to metric as planned.

Views of those who opposed

State government agencies, associations of highway users, the National Transportation Safety Board (a Federal agency which serves as the overseer of transportation safety), and the general public were among those who commented to the Highway Administration about the proposed timetable. Most of their opposition was based on the high cost of conversion with few or no measurable benefits, the fact that they would be forced to metricate when the Metric Conversion Act calls for voluntary conversion, and the possibility of impaired highway safety due to the lack of driver education.

Highway Administration officials told us they believe that the most important fact learned was that metrication is an emotionally volatile subject and their analysis of the responses showed that many were based on patriotism, fear of communism, the need to maintain tradition, or an organized appeal. They felt that it was evident that most of the adverse comments received from citizens came as a result of newspaper articles urging readers to protest use of the metric system.

A question of authority

The National Committee on Uniform Traffic Laws and Ordinances is an independent, nonprofit organization composed of about 140 members representing groups, such as Federal, State, and local highway officials; car, bus, and truck associations; insurance and finance companies; and others involved in highway transportation. The Committee is the custodian of the Uniform Vehicle Code which is a guide for State motor vehicle laws.

This Committee's view is that the Highway Administration does not have authority to promulgate and enforce a timetable for converting highway signs. The Federal Government does not make traffic laws. The Nation's traffic laws are promulgated, adopted, and enforced by the States and their political jurisdictions. An example is the present 55-mile-per-hour speed limit on the Nation's highways. The States changed their

maximum speed laws to comply with the Federal Government's initiative to save energy, not because the 55-mile-per-hour limit was a Federal law.

It is important to note that the 55-mile-per-hour limit is not a Federal speed limit. In January 1974, however, the Congress enacted the Emergency Highway Energy Conservation Act (Public Law 93-239) which required the Secretary of Transportation to withold Federal-aid highway funds from any State with a maximum speed limit in excess of 55 miles per hour. We had been told by a Highway Administration official that Federal-aid purse strings could be used to enforce State compliance metric speed limits. We were also told that the Emergency Highway Energy Conservation Act could be amended to give the Department the same economic sanction authority over those who did not convert the 55-mile-per-hour limit to 90 kilometers per hour. A State could refuse to comply only if it could do without Federal-aid highway funds.

The Committee on Uniform Traffic Laws and Ordinances official said that the Highway Administration's enforcement authority through economic sanctions is very weak and getting weaker as the Interstate Highway system nears completion. The influence of various political forces against use of sanctions has caused them to be infrequently used. It is questionable whether States would make expensive sign changes to retain Federal-aid highway funds. This official also felt that the Congress would be reluctant to amend the Emergency Highway Energy Conservation Act.

<u>Our observations on the Highway Administration's conversion proposal</u>

The attempt by the Highway Administration to implement conversion of highway signs is important because it is the first attempt by the Federal Government to metricate an area which would quickly affect the entire Nation. Conversion's far-reaching effects would require amendment of State traffic codes; education of drivers, law enforcement personnel, and the judiciary; adjustment of State and local budgets; and adaptation of speedometers and odometers among other things. The strong opposition and ultimate withdrawal of the proposal could have an adverse effect on the course of other metrication efforts in the United States.

If the Highway Department had (1) included State and local governments, industry, and other affected sectors in their planning and (2) developed a cost/benefit analysis as carefully as possible and given more consideration to the amount of time needed for education and revisions to applicable laws,

others may have been influenced to voluntarily cooperate with the proposal.

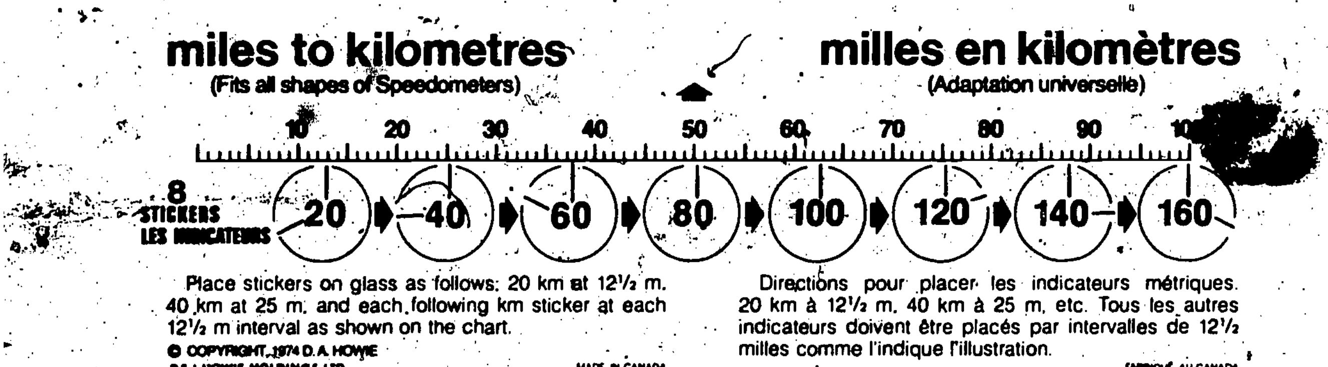
Who volunteers?

The Highway Administration felt that the Metric Conversion Act gave them authority to assume a leadership role in influencing metrication. They choose to do this by "volunteering" to metricate regulations. These regulations would impose conversion on the States. Conversion, then, would be mandatory on the States, which must amend traffic codes and pay for sign replacement, and the highway users, who must comply with these codes. This view, in our opinion, is inconsistent with the intent of the Metric Conversion Act to make conversion voluntary. In our opinion, the Highway Administration's authority to impose such regulations is questionable.

Speedometers and odometers

We also think that the problem of converting speedometers and odometers was too lightly considered by the Highway Administration. The Highway Administration feels that the driver can easily and inexpensively convert a customary speedometer to metric by placing a metrically calibrated decal on the coverglass.

Canada has made decals available to be placed on the speedometer coverglass for its conversion of speed limits in September 1977. We do not as yet know how effective use of these decals has been.

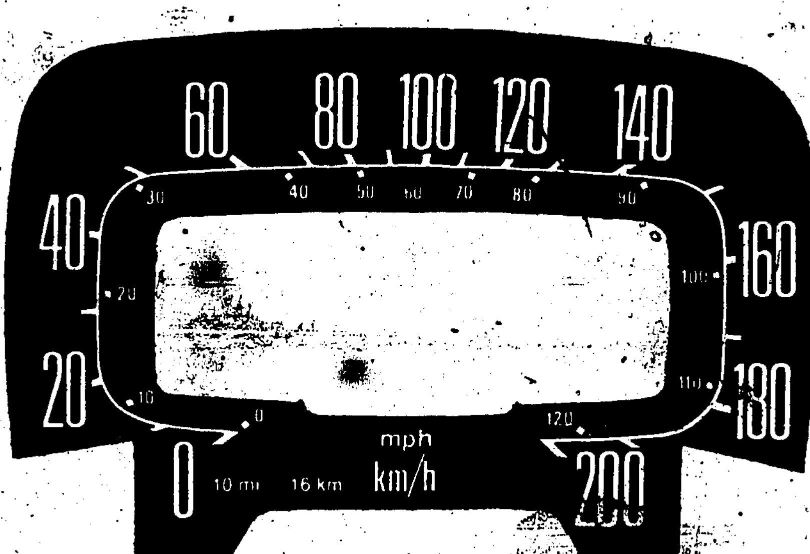


We interviewed two Washington area mechanics whose companies specialize in speedometer repair work. These specialists told us it is not likely that the average motorist will place decals carefully enough to ensure that customary markings are accurately converted. Secondly, they said even if properly placed, the sometimes 2- to 3-inch separation between

the coverglass and the speedometer dial is enough to cause inaccurate readings except when the driver views the speedometer from dead center. (The National Highway Traffic Safety Administration claims that 1/2 to 1 inch would be a more accurate estimate of the average separation between dial and coverglass.) Additionally, night visibility of numbers on the coverglass would be poor at best because speedometers are usually illuminated behind the glass. Numbers on the coverglass would be poorly illuminated in a darkened automobile.

Speedometer specialists said that time for professionals to remove the coverglass and install markings directly to the dial could range from 1 to 4 hours, depending on the automobile or truck, and cost $40 to $75 in labor.

The sales manager of a German multinational automotive instrumentation concern reported to us that many Australian drivers have converted speedometers with a kit marketed by an Australian company. Instructions with the kit explain how the owner can install a metrically calibrated overlay under the coverglass from the front of the instrument panel without having to remove the speedometer from the panel or disturbing any of the speedometer linkages. Because of differences in design, a specific design and instructions were developed for each car make and model. We were given a kit designed to fit the 1973 to 1975 American Motors Matador. The instructions set 20 minutes as the time needed for do-it-yourself installation. For this model the process seemed relatively simple.



The two companies plan to market similar kits in the United States. The manager stated that research is in

progress, not only to develop overlays that will accurately fit the speedometer dials of American cars but to develop easily understood instructions. He estimated that about 1,000 different kits would be needed to cover all automobile models (domestic and foreign) in use. He anticipates, however, that they should be able to market about 300 different kits for the most popular cars sold during the past 10 years.

These kits could be sold for $1.95--$2.50 if U.S. conversion of highway signs is planned with sufficient lead time to allow sales through automobile manufacturers, dealers, and normal parts merchandising outlets. Quick distribution of an estimated 34 to 45 million kits with short lead time will require handling by a large number of people with resulting high markup. In this case kits could cost consumers $5 to $6.

Converting odometers would be a difficult problem. We were told that the odometer is connected to a drive gear on the transmission. GM has kilometer gears which could be used to replace the gear on its cars, but no other domestic company has metric gears. Other cars would have to have an adapter installed and calibrated by road testing over a measured kilometer. Each conversion would be time consuming and could cost over $100. The exact cost would vary with the make, model, and year of the car. Specialists could not give a better estimate because they have never made odometer conversions.

Speedometer and odometer conversion, then, would be very expensive to the driving public if it is to be done in a way that would not introduce safety hazards. This expense would be in addition to the motorist's tax dollars used by the State to change signs and other traffic control devices.

Further study of
human factors needed

Issues, such as whether 90 days, 18 months, or some other period is optimum for completing the speed limit change; whether it is better to convert speed limits before or after other sign changes; when and how to orient the general public; whether metric signs need to be distinctively different from the present signs, and what human factors would be involved in changing from one system to another should also be studied carefully before further attempts are made to metricate highway traffic control.

Dual speedometers required in 1979

In March 1978 the National Highway Traffic Safety Administration issued a regulation for speedometers and odometers

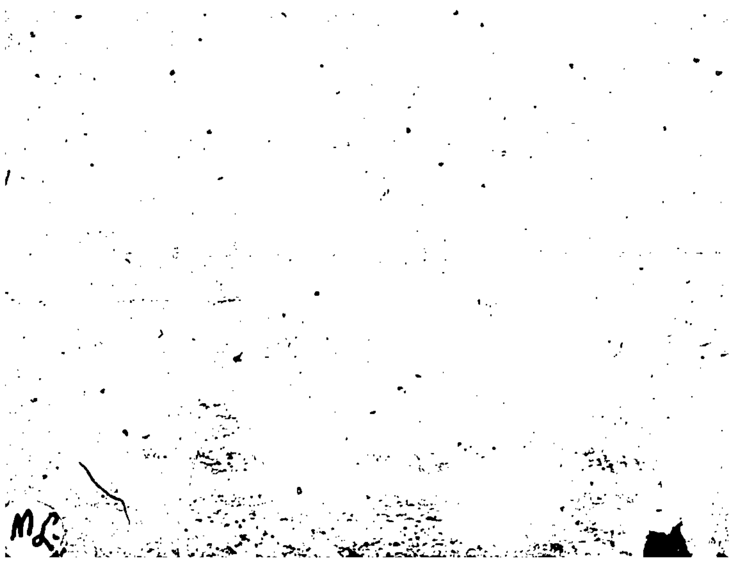
which included a requirement that all new vehicles manufactured after August 31, 1979, be equipped with speedometers that register in both miles per hour and kilometers per hour.

The main purpose of this regulation, according to an official of the National Highway Transportation Safety Administration, was to require automobile manufacturers to use 85 miles per hour or 140 kilometers per hour as the top speed on speedometer dials. This would eliminate higher speeds like 125 miles per hour on the dial which, according to this official, may influence immature drivers to cause a safety hazard by testing their cars to see just how near they can come to the top speed listed on the speedometer. Another purpose was to require odometers to be made more tamperproof, thus protecting the buyer of a used car from purchasing a car which had the odometer set back creating a possibility that the car would have higher mileage and consequently need more maintenance than indicated by the mileage shown.

In the proposal that went out for comment in December 1976, the speedometer readings were to be in customary but gave the automobile manufacturers the option of including metric graduations. Unilaterally, between the time of the original proposal and the final ruling, the Safety Administration changed the speedometer regulation to require all new motor vehicles to have dual speedometers--metric and customary. This ruling, according to an agency official, was made totally on the initiative of the Safety Administration. Whereas automobile manufacturers and others had an opportunity to comment on the original provisions in the regulations, they did not have a chance to comment on the dual speedometer requirement.

This official told us that the decision was influenced by the Department of Transportation order promoting metrication in its administrations and the Federal Highway Administration's actions to have all road signs changed to metric. The "Federal Register" dated March 16, 1978, contained the following statement by the National Highway Traffic Safety Administration:

"Differences between the proposed and final rules. The proposed rule would have required speedometers to be graduated in miles per hour and allowed manufacturers the option of adding graduations in kilometres per hour. The final rule requires graduations in both systems of measurement. This provision will aid the converison of the United States to the metric system, consistent with the Metric Conversion Act of 1975. Some road signs in this country and in neighboring countries already use the system. The dual graduations of speedometers will aid motorists



in becoming acquainted with the metric system. As a result, their acceptance of the system and ability to use it will increase."

Since this regulation was only recently issued, we do not know what impact it will have on motor vehicle manufacturers particularly truck and motorcycle manufacturers. Some automobile manufacturers are already producing cars with dual speedometers. Whether this regulation will disrupt their timing schedules is unknown to us at this time--it will coincide with the introduction of new models in the fall of 1979. More importantly, the measurement portion of this regulation was issued on the initiative of the Safety Administration and was not coordinated with the parties affected. (See ch. 11 for a detailed discussion of the automotive industry.)

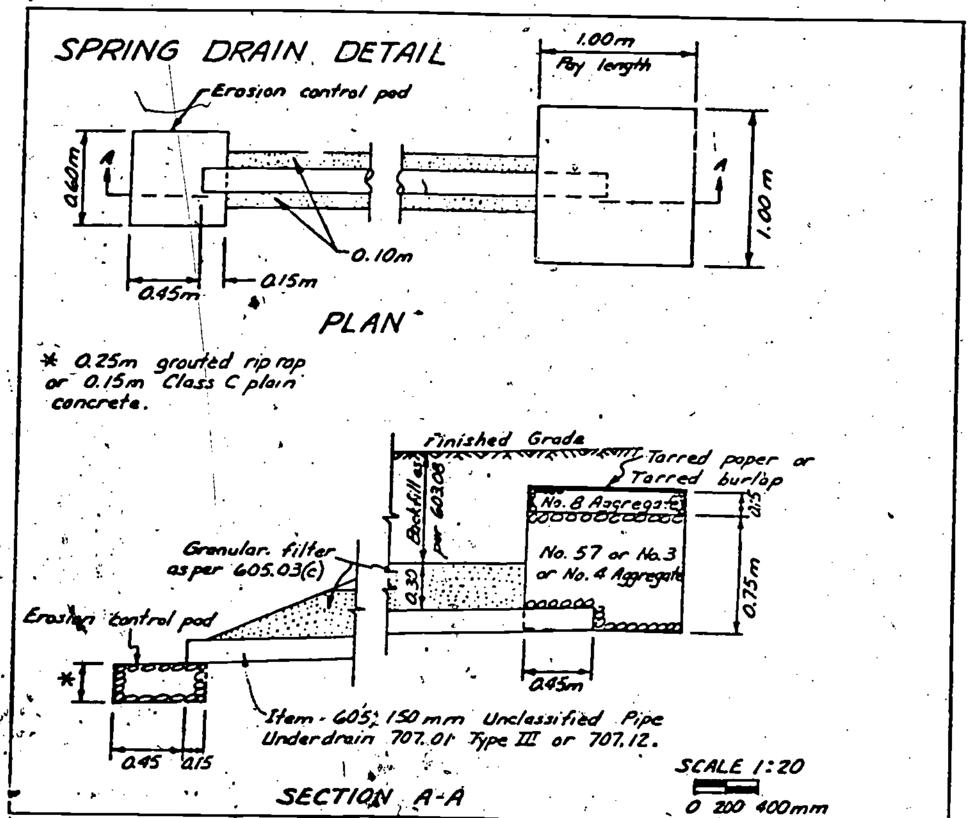
Thus, this appears to be another example of a Federal agency, the second in the Department of Transportation, unilaterally using its authority to promote metrication as indicated by the issuance of the regulation and the statement on its action that the regulation "* * * will aid the conversion of the United States to the metric system * * *."

BUILDING A METRIC ROAD

We found two projects in which metric measurement was used almost exclusively in street and roadway design and construction. The Ohio Department of Transportation resurfaced a portion of one road and surveyed, designed, and constructed two State road improvement projects. The city government of St. Louis Park, Minnesota, completed a 9- to 10- block urban project using metric design and construction. The projects were implemented to identify the problems that are likely to arise when metrics are used in building roads. These projects were done as part of the regular maintenance programs. No special funds were required.

During the design stages of its projects, Ohio purchased metric equipment and supplies for surveyors and engineers. The necessary equipment obtained for field surveying--a 3.6-meter metric level rod, a 30-meter metric drag chain, a 50-meter metric box tape, and a 3-meter metric pocket tape--was available from a Columbus, Ohio, supply house at approximately twice the cost of customary American equipment. Materials needed for design work were metric scales and paper. Scales were ordered locally, but there was a 4-week wait for delivery. Procurement of metric paper and tracing cloth was a greater problem. Delivery of the cloth took an excessive amount of time and nearly delayed the plans. Metric-size paper had to be cut from present stock. There were some complaints about the quality of equipment and supplies, but

generally, procurement of surveying and design equipment and materials was not a great problem.



Construction detail showing metric specifications

Courtesy of the Ohio Department of Transportation.

In general, education of personnel working on the jobs was minimal. Field surveying crews were given a 1/2-hour orientation and then given the metric equipment to practice with for a few hours. After about a week of field work, they became fairly accustomed to working in the metric system. On-the-job training after short orientation was also used for design personnel. Results were reported to be good, and accuracy of measurements and quality of work were generally as good as usual, although some workers said they had been extra careful because they were working in a new system.

Ohio also insisted that contractors use the metric system in all measurement and accounting during construction. With this in mind Ohio determined that the range of bid amounts was not unusual, and no bids seemed to be greatly increased because of the metric nature of the projects.

Contractors reported a few problems, including increased price of ready-mixed concrete to compensate the supplier for converting his plant to metric (the total cost of plant conversion was $3,500) and difficulty in obtaining the necessary metric measuring devices. Training of personnel on a need-to-know basis was not a problem.

The City Engineer of St. Louis Park believes that metrication is coming. Therefore, he ordered a 9- to 10-block street revamping project to be done as completely metric as possible to identify the advantages and problems. The contractors' bids on the project were about the same as a non-metric job would be, although only four of the usual six to eight contractors submitted bids. The city's design costs were about 20 percent higher because engineers' production was reduced during a period of relearning and using nearly forgotten metric measurement skills. There was also lost time and confusion on the contractor's staff. Engineering and design equipment costs were minimal, about $30. Most of this was spent for metric rules, tapes, and drafting paper.

Dual measurements were used on the plans sent out for bids so that contractors would have a familiar base for estimating. Hard conversions were avoided when they would involve new construction machinery or materials which may have to be manufactured to metric standards, such as manhole covers or curbs. Street widths, however, were 12 meters; concrete was mixed using metric quantities of ingredients and poured in cubic meters; and sidewalks were square meters in area and centimeters in thickness.

There was some distrust among residents whose driveways would be affected because they thought that the 10-meter width planned for the new metric driveway was smaller than the 30 feet they already had. Actually their metric driveway was about 3 feet wider. Some had to be given an actual demonstration before they were satisfied.

Although both the Ohio and the St. Louis Park road building experiences were successful and identified surmountable problems, both decided not to plan further metrication until Federal policy and metrication of highways "catch up." Officials in both situations felt that the metrication of road construction is not advantageous at this time because the problems encountered would be expensive to overcome, on a large scale, and there were no benefits.

An experiment with signs

Ohio installed 33 dual destination signs on Interstate Highways to determine the changeover time in the public

OHIO INSTALLED 33 DUAL DESTINATION SIGNS ON HIGHWAYS TO DETERMINE PUBLIC AWARENESS AND ACCEPTANCE OF THE METRIC SYSTEM.

PHOTO COURTESY OF THE OHIO DEPARTMENT OF TRANSPORTATION.

awareness, acceptance, and general understanding of the metric system and the effect of the signing system on the change. Data was obtained by administering questionnaires to motorists at rest areas on the affected Interstate Highways before and after the sign changes. Two thousand questionnaires were administered in September 1973; 1,440, in April 1974; and 1,570, in August 1974.

After analysis of the questionnaires, Ohio concluded that motorists were about evenly divided on the issue of metrication. The proportion of drivers in favor of changing to the metric system decreased over time but still maintained a slight lead. It also found that the dual unit signing system had no beneficial effect on awareness, understanding, and acceptance of metrics. Seventy-five percent of the respondents indicated, however, that dual unit destination signs would be helpful in the transition of highways to the metric system. The ability of motorists to use the correct customary-to-metric conversion for distance increased over time.

A LONG HAUL FOR RAILROADS

The Federal Railroad Administration is taking a low profile in conversion to metric in that it will gear its metrication activities to the rate of conversion by the railroad industry. Its future policy will be formulated within the Department of Transportation's guidelines. The members of the railroad industry seem generally opposed to conversion because (1) they do not see an economic advantage and (2) they have an immense investment in fixed plant (rails, ties, classification yards, etc.) and rolling stock (locomotives, freight cars, switching engines, passenger cars, etc.) with long-life expectancy which would require redesign and maintenance of dual inventories of equipment over an extended time.

Officials said that railroad safety regulation is the only area in which the Railroad Administration could require change to metric by the railroads. They could possibly revise regulations dealing with track safety, freight car safety, safety appliances on trains and locomotives, motive power safety, and other Federal safety regulations to include metric measurement. Even in this case, the conversion would be to metric equivalents (soft conversion) to avoid drastic changes in the physical dimensions in plant and equipment.

The Northeast Corridor Development project and the Alaska Railroad, both operating under the Railroad Administration, are the only major federally controlled railroad operations. The Northeast Corridor Project Office, which is working toward improving railroad service between Washington, D.C., and

Boston by improving track, signals, electrification, bridges, and the like has had discussions of metrication impacts since 1975. However, we were told that nothing of consequence has been done. The Northeast Corridor group had considered using metric fasteners on some new installations and metrication of the catenary systems on new installations. (The catenary is part of the structure that transmits power to the locomotive motor.) Neither consideration has been decided.

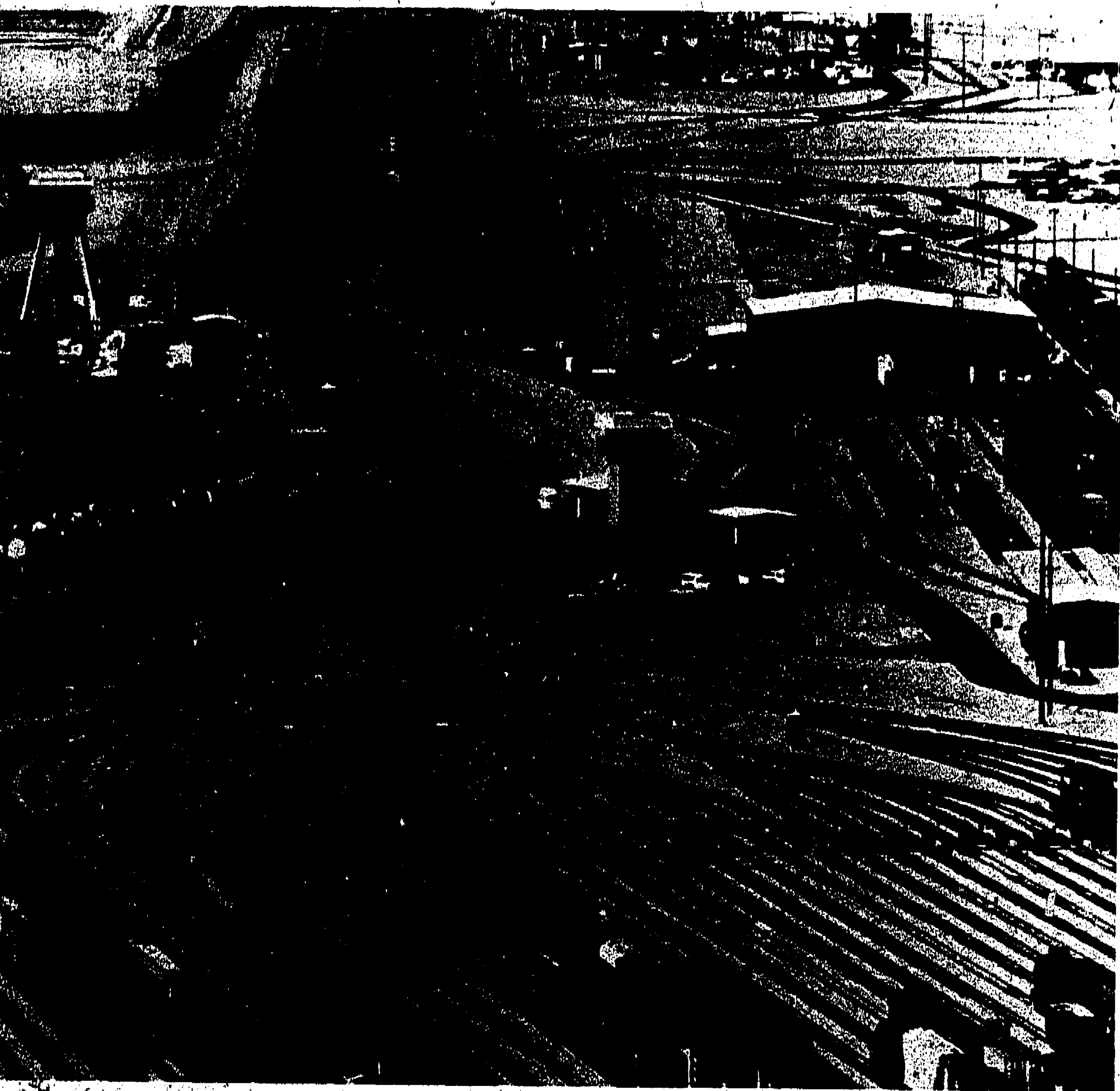
A Northeast Corridor official said that hard metrication of railroad construction would require extensive standards revision and redefinition. The railroad industry is very conservative; it is currently using many standards made before 1920 and is reluctant to change. Soft conversion would accomplish little more than a change in language. The official feels this is a waste of time. With a target date of February 1981 set to complete the Northeast Corridor development, there is no time, especially without strong leadership and mandates, to do much about metrication.

Officials at the Association of American Railroads, which represents 90 percent of the railroad industry, told us that the large American railroads are reluctant to even discuss conversion to metric. The two overriding reasons for this attitude are:

--A conversion by the railroads to metric would require a tremendous outlay of money for no apparent real return or benefit. Because of the depressed financial condition of most railroads, funds are not available for this, even if they so desired.

--Due to the magnitude of the rail system and the long average life of equipment, the conversion would take a long time and cause numerous inconveniences and could hold up the progress of the rehabilitation of the entire industry. (There are about 324,000 miles of track, 1.7 million railroad cars, and 27,600 locomotives in the United States.)

Before any metric cars can be put on line, all parts of the railroad system must be able to handle and maintain them. Although there are many different railroad companies, each is considered to be part of the one North American--United States, Canada, and Mexico--rail system. Freight cars must be interchangeable with capability for use throughout the system. One standard gauge (width) track throughout the system (4 ft. 8-1/2 in.) allows rail cars to move freely from one railroad to another. Although in time, metric conversion of other railroad equipment may occur, it is not probable that hard conversion of track gauge will ever be considered.



RAILROADS HAVE AN IMMENSE INVESTMENT
IN FIXED PLANT AND ROLLING STOCK.

PHOTO COURTESY OF THE ASSOCIATION OF AMERICAN RAILROADS.

The railroad companies really do not know whether the Nation will ever metricate. However, the Association of American Railroads is developing a preliminary plan of action to use in the future if it seems that railroads must convert. The plan will attempt to (1) define all areas and activities of the railroad industry that could be involved in metrication, (2) provide a tentative timetable for conversion of each item, considering not only the railroad industry but the ability of suppliers to furnish needed equipment, (3) consider what education will be needed for employees and when it should be given, and (4) insure that coordination and compliance with standards are achieved throughout the industry.

The Association of American Railroads is a member of the Railroad Rolling Stock Committee of the Canadian Metric Commission. Since the Canadian railroad industry is so intimately related to the U.S. industry, the Canadian railroads have had to delay hard metrication activities until the United States moves, although Canada is about 2 years ahead in planning.

Canada's Railroad Rolling Stock Committee encompasses companies primarily engaged in building, rebuilding, and operating locomotives and railroad cars. The Committee stated that the U.S. conversion will impose constraints on the Canadian railroad conversion plan if the Association of American Railroads defers the writing of new specifications and codes. Canada has set 1983 as a target date when all operations will be predominantly metric.

Canada's Rail Transport Committee, which comprises those companies primarily engaged in operation of railways for passenger and freight, has also set 1983 as a target to be predominantly metric. However, it too states that while the industry is attempting to adhere to the Canadian National Program of Guidance Dates for Metric Conversion, the interrelationships of railway operations between the two countries constrains the industry in that the conversion must be coordinated with that of the U.S. railroads.

Conversion of tariffs

One metrication problem to be faced by railroads and other commercial transportation concerns (carriers) which transport goods is the conversion of tariffs--the schedules of rates, charges, and regulations for transportation of freight. Tariffs have every conceivable expression of weights and measurement, all of which must be analyzed and changed if the carriers convert to the metric system. Tariffs include the freight rate plus service charges for such

things as switching services, measuring tonnage, reconsigning shipments, loading, unloading, and icing perishable goods. Shipment descriptions and shipping conditions are defined in weights, densities, capacities, gauges, viscosities, dimensions, temperatures, pressures, and other measures.

All carriers subject to the Interstate Commerce Act and the Federal Aviation Act are required to have their tariffs reviewed by the Interstate Commerce Commission or the Civil Aeronautics Board and also make them available for public inspection before publication. These agencies examine the tariffs for statutory and regulatory requirements and the impact they may have on users, especially small customers. They may be accepted, negated, or suspended. Published and filed tariffs are binding on the carrier, the shipper, and the persons receiving shipments. The provisions become an inherent part of each contract represented by a bill of lading.

Presently, the United States has about 20,000 regulated carriers. These include railroads, airlines, motor carriers, pipelines, transportation brokers, and express agencies who publish prices for transportation. A tremendous library of tariffs exists, the vast majority in the customary system. An Interstate Commerce Commission official said that there is no accurate count of the number of tariffs, but they run into millions of pages. To give an idea of the volume, he said the Commission processes about 400,000 tariff changes annually. This amounts to approximately 1.5 million pages of material. This does not include the thousands of unchanged tariffs or new tariffs.

In July 1976, to open the door for rate conversion, the Interstate Commerce Commission issued a statement to the effect that railroads, motor carriers, and other carriers, under their regulation could convert tariffs to metric but easily understood conversion tables must accompany the published schedule. While the Civil Aeronautics Board has not taken an official position, it told us that there would be no objection if the air freight industry wished to convert rates. At this time neither of these agencies intends to initiate tariff conversion, but will cooperate with the conversion of industry.

Conversion of tariffs will be a very difficult and expensive undertaking. Its difficulty is compounded by the fact that prices must not be substantially increased or decreased in the process. Therefore, soft conversion would have to be made. In simplest terms soft conversion would entail establishing appropriate conversion factors for all the measurement descriptions that are used in describing the tar[illegible] on which costs are calculated. For each measurable proper[illegible]

in the present system, there must be an acceptable physical quantity defined in the metric system by which it can be quantitatively compared. A set of base concrete units must be contrived, one for each base quantity, from which a complete translation table can be computed.

An official of the Southern Freight Tariff Bureau, which is one of the nonprofit agencies established by groups of carriers to publish rates, says that one problem is that there are no absolute metric equivalents to customary quantities, only approximate equivalents. For example, 1 ounce equals 28.3495 grams, or virtually as many places to the right of the decimal point in fractional units as you would care to express.

This then leads to the next step, deciding on the techniques to be used in rounding off, keeping in mind that metric rates must remain as near the customary rates as possible. An official of the Association of American Railroads told us that the number of significant digits used in the rounding system could make the difference between profit and loss for a shipment. Another official felt that there may be a need to compute conversion factors out to eight decimal places.

Once equivalents are established and the rounding system is decided, the actual conversion would take place. This, among other problems, would require recomputation of the vast library of rates and schedules, changing records of the tare weight and capacity of freight cars and motor carriers; reprograming of computers, and making adjustments to marketing and other statistical programs.

The "Official Railway Equipment Register," which publishes the inside-outside door opening measurements and cubic capacities of all freight cars, would have to be converted. Publications which define package descriptions and regulations and the specifications for shipment of hazardous materials prescribed by the Department of Transportation would also have to be converted to a precise degree. Personnel involved would have to be taught to understand metric units as easily as they do the conventional units of weights and measures. These and the many other changes that would be necessary could constitute an enormous amount of work and expense.

There are many more people who ship goods by rail, air, highway, pipeline, etc., than there are carriers. (No one knows how many.) It would be difficult to assess the impact of metrication on these shippers. If metrication occurs, all agreements will have to be reviewed by carriers and shippers to account for the changes in units.

Both carriers and shippers have been increasing their use of computers in tariff computations. Computers are being used in such areas as freight tonnage, cost analysis, shipment routing, bill of lading preparation, and payments. Conversion would necessitate programing changes to accommodate changes in units, rounding problems, and other statistical programs. A railroad rate bureau study stated that if a rounding system that required more than three digits to the right of the decimal point is adopted, their present computer program package will not accommodate it, and to change could be detrimental to the progress already made in computerization. The study also stated that during the transition period, it would be necessary for computers to maintain dual capability. This would be a problem. (See ch. 18 for further discussion of computers.)

Although there is no estimate of the costs of tariff conversion, indications are that they will be substantial. The work involved would be enormous. We could not identify direct benefits to carriers or shippers from metrication of tariffs.

MARITIME ACTIVITY

In the United States the maritime industry is an essential but relatively small industry. Shipbuilding, for example, represents only about 1 percent of U.S. steel consumption. The industry includes ship and terminal operations, shipbuilding, marine equipment manufacture and supply, naval architecture, and marine and marine-related engineering.

The maritime industry has been confronted with a mixture of measurement systems. Some components produced in metric countries have followed metric design although not always SI metric; they may be hybrid metric systems. Components made in other countries tend to be in inch design except for parts, such as bearings, that have been produced to international standards. There have been problems when parts made in different units must be used together. The maritime industry has also had to deal with a confusing variety of units used in international commerce.

Planned conversion would be beneficial to the maritime industry in terms of (1) rationalized engineering standards--the opportunity to develop standards that reduce the number of product sizes, (2) reduced inventories--an opportunity for cost reduction through international standardization of a smaller number of product sizes, and (3) coordinated education and training--the opportunity to eventually teach one system rather than both metric and customary.

In mid-1972 the Maritime Transportation Research Board of the National Research Council, National Academy of Sciences, began developing a comprehensive plan for orderly conversion to metric for the U.S. marine industry and those Government agencies concerned with maritime matters. Because they felt that metrication was proceeding at an increasing pace in the United States, the Board agreed to start with the premise that the United States would soon or eventually go metric. The report, consequently, did not consider the questions:

--Should the Nation go metric?

--What are the benefits and costs of U.S. metrication (e.g., the extent to which conversion will enhance U.S. penetration of foreign markets or, conversely, penetration of U.S. markets by foreign exporters.)?

The report, "Maritime Metrication: A Recommended Conversion Plan for the U.S. Maritime Industry," was published in December 1975 just after enactment of the Metric Conversion Act, which of course, does not include a target period or a policy of converting to a predominantly metric system. However, it is still, except for time frames, held by the Maritime Administration as the metrication plan for the maritime industry.

The report recommended a conversion program which discusses the organizations that make up the maritime industry, their interdependencies, and the recommended time phasing of conversion to the metric system--soft conversion where necessary, followed by hard conversion of design and manufacturing. All activities, if kept on a tight schedule, were planned so that conversion to metric would be substantially complete within 8 years.

We discussed the plan with an official of the Maritime Administration, the agency which aids in the development, promotion and operation of the U.S. merchant marine service. He said that the report was a good one, but the time frames recommended were not attainable because (1) the Metric Conversion Act did not establish a mandate for metrication, (2) the U.S. Metric Board had not yet been established to provide coordination, and (3) there has been no marine activity in The American National Metric Council since 1974. (We found that plans are afoot to reactivate ANMC's Maritime Sector Committee with the American Shipbuilders Council as secretariat.)

The Maritime Administration official said that the U.S. shipbuilding industry is very small by comparison with other

industries and does not have the clout to force suppliers to provide metric materials and supplies. He indicated that the industries which supply the maritime industry's needs do not seem to be anxious to change to metric. The maritime industry will have to wait until metrication is made economical to these suppliers by other industries, such as the automobile manufacturers. In contrast, major foreign shipbuilding nations, such as Japan, Germany, and the Scandinavian countries, have no problem because their suppliers have metric capability. However, their production is in CGS metric 1/ which differs somewhat from SI metric.

The Maritime Administration believes that metrication should come from within the industry and not be pushed by the Government. The Maritime Administration should keep pace, coordinate, facilitate, and assist where possible.

The Maritime Administration had a firm of marine consultants develop a plan recommending the role it should play in leading the maritime industry into conversion.

The plan, "Metric Conversion Study for the Maritime Administration," concluded that the Maritime Administration should follow the spirit of the Metric Conversion Act, by assuming the philosophy that industry must voluntarily set the pace in metrication. The role of the Maritime Administration, therefore, should not be one of forcing metrication on the industry, but rather that of a coordinating and facilitating agency. It estimated that to do this, about 28,300 staff hours will be required over a period of at least 10 years. We calculated that this would cost, including overhead, about $480,000.

The Maritime Administration has accepted the lead role and is in the process of drafting policy for action. In implementing this leadership role, it expects to encourage Government organizations which have regulations affecting maritime matters to metricate them in support of maritime industry metrication efforts. The Maritime Administration will also give assistance to industry in identifying and converting standards, specifications, and manuals requiring change.

The Maritime Administration has already attempted to influence metric conversion in the shipbuilding industry by issuing both the "Standard Specifications for Tanker Construction" and the "Standard Specifications for Diesel Merchant

1/Centimeter, gram, and second are used as base units for length, mass, and time.

METRICATION OF THE SHIPBUILDING INDUSTRY IS DEPENDENT ON METRICATION OF ITS MANY SUPPLIERS.

PHOTO COURTESY OF THE MARITIME ADMINISTRATION.

Ship Construction" in dual units, with the equivalent metric units shown first and customary units in parentheses. These specifications are for the building of subsidy ships, those ships for which the U.S. Government subsidizes the difference in cost between a ship built in America of domestic components and materials and one built in a foreign shipyard.

A view from industry

The American Institute of Merchant Shipping is an association of all U.S. flag ships (about 35 companies). The members include companies operating ocean liners, dry cargo ships, coastal ships, and tankers. The Executive Secretary told us that at this time the industry is reacting to others. The industry has adopted a "follow on" position in metrication. The Maritime Transportation Research Board's Plan is the plan the industry is to work under. Much of the maritime industry is presently compatible with metric, we were told, because many of the engineering features--pumps and boilers--on ships are either metric or dual now. Therefore, engineers are somewhat familiar with the system. Navigation--use of compass, sextant, and other instruments--will not be disturbed for a long time. He also mentioned that the U.S. maritime industry uses only about 1 percent of the Nation's steel output; therefore, it is too small to cause metric conversion of the steel industry because of its demands. Although very little is being initiated now, he thought the maritime industry would be quite willing to convert when necessary.

U.S. Coast Guard

The Coast Guard is charged with implementing laws that are concerned with safety at sea, in harbors, and all the navigable waters of the United States; and marine property, including the safe carriage of cargoes. The Coast Guard approves plans for construction, repair, and alteration of vessels; approves materials and equipment used in the construction and operation of vessels, inspects vessels and their equipment; issues permits for vessel operations that may be hazardous; and issues licenses to U.S. Merchant Marine officers, seamen, and harbor pilots.

The Coast Guard policy toward conversion is generally one of keeping pace with conversion in the private sector. The Coast Guard plans to use metric in its activities consistent with the operational, economical, technical, and safety considerations which are in the best interests of the service. The system in which an item is originally designed is expected to be retained for the life of the item unless conversion is necessary or advantageous. When the item being procured is a military item without a commercial counterpart, metric

specifications may be developed as the need arises. (During time of war, the Coast Guard becomes a part of the U.S. Navy.) Metrication of Coast Guard operational activities will keep pace with the Navy.

We were advised that in the Coast Guard, the Office of Merchant Marine Safety, would have a major role to play if regulations are changed to metric. Their regulations cover such things as allowable boiler pressures, strength of boilers and tanks, and design of cargo compartments for transporting hazardous materials. Metric conversion would call for changes in these regulations. They are revising older regulations which need updating. Metric conversion is being addressed in all new regulations. In many cases, the conversion is soft. If, however, regulations are hard converted to metric, adequate time must be allowed for shipbuilders to incorporate the new specifications into designs for ship construction. Hard conversion to SI units is pending an agreement in the International Marine Consultative Organization, a United Nations unit. Coast Guard representatives are currently working through this organization to produce an equitable and internationally acceptable formula for conversion.

The Coast Guard feels that transition to metric usage will be evolutionary, involving principally new systems and facilities and will normally not include the redesign and modification of existing systems. Because ships have an expected life of 20 to 40 years, changeover will be slow. Industry activity will determine the pace.

Officials at the Coast Guard Office of Boating Safety, which promulgates regulations for the equipment and operation of pleasure boats, stated that they also are not planning to metricate these regulations until the boating industry takes the lead. They also said that there is no advantage for the Office of Boating Safety to change regulations now.

The officials felt that the metrication of marine motors is closely tied in with the conversion of the automotive industry because most boat engines are manufactured by that industry. They noted that two major foreign makers of marine motors use customary specifications in manufacturing motors for use in the United States.

The Office of Boating Safety has recently rewritten regulations for marine fuel, electrical systems, flotation, and horsepower. The customary system was used. These officials said that changeover to metric would have required massive changes in the technical parts of the regulations.

Maritime freight rates

Although most rates used are based on customary measurements, some of the conferences (groups of shipping companies) are filing rates based on the metric system with the Federal Maritime Commission. The first conferences to take this action were the New York-based Far East Conference and the Pacific Westbound Shipping Conference of San Francisco. The shiplines in these conferences transport freight from the United States to the Philippines, Cambodia, China, Thailand, Hong Kong, Vietnam, Japan, Korea, Taiwan, and Siberia. Metric rates were effective January 1, 1977. A conference official said that conversion of rates to metric would have to be done sooner or later. The two conferences decided to do it now. Under the change, metric rates are based on a ton (1,000 kilograms which is equal to 2,200 pounds), or a volume of 1 cubic meter. Before the change, tariffs were based on the 2,000-pound ton or 40 cubic feet. Maritime carriers may charge for a shipment on a basis of weight or volume, whichever brings in more revenue.

Most shippers still ship materials in customary sizes or weights. However, the conferences' shiplines convert the sizes and/or weights to metric. Exact equivalents are used and there were no increases in rates. "Tweed's Accurate Metric Cubic Tables" is the guidebook used at the piers to convert all nonmetric weights and sizes to metric.

Representatives of both conferences told us that rate conversion was not a big problem. The conferences' statistical programs included all items for which rates were to be changed. It was simple to analyze the items and make metric equivalent conversions. A Far East Conference rate analyst took about 3 months to do the job. The Pacific Westbound Conference took about 2 months to do its approximately 750-page rate book. The Pacific Conference estimated that $50,000 was spent in the process, but most of this was expended in having new rate books printed and distributed.

The Federal Maritime Commission told us they have examined the changes and found they complied with regulations. The Commission's involvement entails examination of the new metric tariffs to ensure that there are no substantial price increases over the rates charged for customary shipments. The Maritime Commission expects tariff conversion to continue with the U.S. ships which carry cargo to foreign ports but remain customary for a long time for ships engaged in coastal and domestic trade. This is another example of metrication leadership by firms engaged in foreign trade.

Far East Conference

TARIFF NO. 27 **F. M. C. NO. 10**

From: UNITED STATES ATLANTIC and GULF PORTS
To: YOKOHAMA, KOBE, OSAKA, NAGOYA & TOKYO, MANILA, HONG KONG, KAOHSIUNG/KEELUNG and BUSAN
For applicable surcharges see page 3 and for rates to other ports see pages 38 thru 44.

ORIG. REV.	PAGE
3rd Revised	205
CANCELS	PAGE
2nd Revised	205
EFFECTIVE DATE	
December 16, 1977	
CORRECTION NO.	2937
CANCELS CORR. NO.	1378

EXCEPT AS OTHERWISE PROVIDED HEREIN, RATES APPLY PER TON OF 1000 KGS. (2204.62 LBS.) (W) OR 1 CUBIC METER (35.314 CU. FT.) (M), WHICHEVER PRODUCES THE GREATER REVENUE.

"C" - denotes "CONTRACT" rate. "TAR" - denotes "TARIFF" rate.

Commodity	Group Ports / Rate Basis	1 Nagoya Yokohama Kobe Osaka Tokyo $	2 Manila $	3 Hong Kong $	4 Kaohsiung Keelung $	5 Busan $	Commodity Code
Corn Meal for Human Consumption Balers	Wt G A: C	154.00 162.00	146.00 154.00	150.00 158.00	155.00 163.00	148.00 156.00	047 0220 09
Corn Meal, Donated for Relief or Charity by United States Government Agencies Bags Rule 28	Wt Tar A: Tar	112.00 117.00	107.00 112.00	109.00 114.00	115.00 120.00	109.00 114.00	047 0220 33
Sorghum Grits, Soy Fortified, Donated for Relief or Charity by United States Government Agencies Bags Rule 28	Wt Tar A: Tar	112.00 117.00	107.00 112.00	109.00 114.00	115.00 120.00	109.00 114.00	047 0250 33
Breakfast Cereals, Prepared for Cooking, Except Rolled Wheat and Bulgur Wheat - N.O.S., Donated for Relief or Charity Bags Rule 28	Wt Tar A: Tar	135.00 142.00	127.00 133.00	131.00 137.00	136.00 143.00	130.00 136.00	048 1130 03
Bulgur Wheat, Prepared for Cooking	Wt C A: C	127.00 133.00	[illegible] [illegible]	123.00 129.00	130.00 136.00	123.00 129.00	048 1140 00

A: Advance in Rates effective March 1, 1978.

CREDIT: COURTESY OF THE FAR EAST CONFERENCE

PAGE FROM FAR EAST CONFERENCE TARIFF BOOK SHOWING RATES BASED ON KILOGRAMS AND CUBIC METERS

In domestic commerce minor changes in regulations will have to be made to allow carriers to file tariffs in metric. For example, one regulation requires reports on a revenue ton basis; another requires small vessel exemption expressed in tons and liquid bulk exemption expressed in gallons; and still another, the Automobile Measure Guide, requires automobile sizes to be reported in cubic feet.

ST. LAWRENCE SEAWAY

The St. Lawrence Seaway Development Corporation of the Department of Transportation operates and maintains, within the territorial limits of the United States, the portion of the St. Lawrence Seaway between Montreal and Lake Erie. The Seaway is a network of navigable waters comprised of the St. Lawrence River and the five Great Lakes and consists of some 9,500 square miles of waterway. It provides access to important cities from Minnesota to the Atlantic Ocean.

The Seaway Corporation began planning for metric conversion in 1975. Because operation of the St. Lawrence Seaway is shared by the Corporation and the St. Lawrence Seaway Authority of Canada, the United States and Canada are cooperating and coordinating metric activities so that there will be no confusion among the workers, shippers, and others who operate or use the seaway.

As a consequence, their metric conversion activities have progressed somewhat ahead of other agencies in the Department of Transportation. At present, markings on the locks of the Seaway, air and water temperature monitoring devices, water level guages, and tonnage tolls charged to vessels are being changed. The Montreal-Lake Ontario map is also being revised to metric units.

Although the Seaway Development Corporation already has some capability for recording water levels in metric, it must distribute its reports to other U.S. agencies in customary because they are not prepared to handle metric data at this time.

The Corporation has already made progress in training the approximately 100 people of a total staff of 180 who most need metric skills. Training is being conducted at St. Lawrence University in Canton, New York, and Canadian schools.

URBAN MASS TRANSPORTATION ADMINISTRATION

The Urban Mass Transportation Administration of the Department of Transportation is responsible for the development of improved mass transportation facilities and equipment.

The metric coordinator said that Urban Mass Transportation was probably the least developed in metrication planning than any of the other agencies in the Department of Transportation.

In March 1976 the Urban Mass Transportation representative on the Department's Metrication Working Group submitted a plan recommending that Urban Mass Transportation establish a policy toward metrication which would support private sector activities, eliminate statutory and other barriers to change, establish target dates for key conversion events, assist in metric education, convert statistics and reporting to metric units, and begin procurement by metric specifications.

The Deputy Administrator, however, was concerned that such a policy could commit Urban Mass Transportation too deeply into implementing actions beyond available financial and personnel resources. The recommendation was not approved; however, the Urban Mass Transportation Administration is attempting to determine the extent of such impacts in the metric conversion plan it is preparing in response to the Department's order.

The official we interviewed said the Urban Mass Transportation Administration is not in a position to dictate metric usage to the cities receiving its grants, but he felt that it could play a role in promoting metric among transit authorities and industry as one way of reducing costs over the long term through savings in staff time, possible expanded markets for transit equipment manufacturers, and the opportunity to standardize parts and other supplies.

He said that manufacturers of equipment would probably resist change to metric because changes in design will be perceived as introducing new problems in performance. Maintaining dual inventories would also be a cost which must be considered. The long-life expectancy of buses and the 20- to 30-year expectancy for rail cars will prolong the period when dual parts inventories must be maintained.

However, once Urban Mass Transportation develops its plan for conversion, it may be possible to influence some of the transit authorities receiving grants to implement their projects in metric. This would mean these authorities would have to specifically require contractors to use metric designs. At present most planning and procurement is done according to performance specifications, which allow the contractor latitude to establish measurement sensitive matters as he sees fit as long as performance meets specifications.

CONCLUSIONS

Metrication of transportation is proceeding at a slow pace. Transportation interests--motorists, motor freight carriers, railroads, and ship companies--see conversion as a costly undertaking with minimal benefits. Whether customary or metric, the costs of travel, elapsed time from point to point, the performance of vehicles, and the life of equipment remain the same. Interstate travel and commerce is totally independent of activity in other countries; therefore, there are no advantages to using the same measurement system. No one has presented paramount reasons why transportation should convert.

To implement the spirit of voluntary conversion, the first determination to be made is whether it is in the best interests of the transportation sector to convert. The impetus, however, should come from the private sector and not the Federal Government. If it is determined that the private transportation interests wish to voluntarily convert, it is imperative that the Federal Government facilitate the change through coordination, effecting necessary changes in regulations and other supporting activities with due consideration to all affected parties, including the general public. The aborted Federal Highway Administration plan to require conversion of highway signs is an example of a Federal attempt to implement conversion before the affected sectors expressed desire or readiness to do so. Another example is the National Highway Transportation Safety Administration's requirement that all new motor vehicles have dual-labeled speedometers beginning on September 1, 1979.

RECOMMENDATIONS TO THE SECRETARY OF TRANSPORTATION

Because of past actions by the Department, the importance that the voluntary aspect of our current national policy be complied with, and departmental metrication activities may adversely affect the Nation, we recommend the Department of Transportation adopt metrication policies, change regulations to metric specifications, or mount metrication activities only when the initiative comes from the sectors which will be affected--industry, the States, and the general public. In such cases, the Department should inform the public of the impact of those conversion actions that affect them and hold public hearings to obtain their comments which should be considered in any final determination on such actions.

CHAPTER 11

AUTOMOTIVE INDUSTRY PROVIDES AN IMPETUS

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The decisions to convert to the metric system by large multinational corporations, particularly by automotive manufacturers, is having a major impact on metrication in the United States because of their size and the extent of their operations. Such corporations also exert considerable influence over their suppliers.

The General Motors Corporation (GM) is preeminent in the automotive industry, and its influence overall is probably greater than any other single industrial corporation in the United States. GM has decided to convert its U.S. operations to the metric system. As a result, its competitors and suppliers (some 47,000 companies), which include other major segments of the American economy, such as the steel and rubber industries, are following GM's lead. If suppliers are to retain GM's business, or for that matter the business of any other major customer that is converting, they must provide metric products. Competitors and suppliers told us that if it were not for GM's conversion, metrication activity in the United States would be at a relative standstill.

Our review of metrication in this industry concentrated on the four major automobile manufacturers in the United States, with emphasis on GM because of its position in the economy and the metric conversion effort. We interviewed officials of these companies and reviewed company conversion policies, plans, organizational relationships and structures, and annual reports. We also interviewed officials of several automotive industry trade associations. In addition, we visited large and small suppliers of automotive products, automobile dealers and mechanics, and various national associations. We also spoke with union officials.

AUTOMOTIVE INDUSTRY'S SIGNIFICANCE ON THE U.S. ECONOMY

The automotive industry is basic to the American economy. "Time" magazine has stated

> "* * * no other single category of commercial activity more acutely reflects the State of the nation's economy than auto sales."

On April 25, 1978, GM's Chairman predicted that sales of domestic and imported cars and trucks would number 15.5 million vehicles in 1978, with automobile sales accounting for

11.8 million of this total. Motor vehicle and parts manufacturers employ over 1.3 million persons. An estimated 80,000 firms supply materials, parts, components, and services to the manufacturers. About 32,000 dealerships, with about 775,000 employees, throughout the United States sell and service motor vehicles. In addition, thousands of rental and repair businesses and numerous auto supply stores and gasoline dealers are all connected in some way with the industry.

The four largest domestic automobile manufacturers are GM, Ford, Chrysler, and American Motors. The items they produce include cars, trucks, buses, motor homes, automotive parts and components, locomotives, earth-moving equipment, and household appliances. The first 3 are in the top 10 of "Fortune" magazine's 1977 ranking of the 500 largest industrial corporations.

	Rank	Sales (billions)
GM	1st	$55.0
Ford	3d	$37.4
Chrysler	10th	$16.7
American Motors	110th	$ 2.2

In terms of sales, GM is the largest company in the automotive industry and the largest industrial corporation in America. Between January and April 1978, GM's sales comprised 56 percent of domestic companies' automobile sales. By comparison, the Ford Motor Company had about 29 percent; Chrysler, 13 percent; and American Motors, 2 percent. GM also

--employed over 500,000 persons at 117 plants in the United States,

--had about 13,500 dealerships selling and servicing its cars and trucks,

--did business with about 47,000 suppliers,

--had subsidiaries and associated companies which operate in 35 countries, and

--sold products in virtually every country in the world.

PAST METRIC INVOLVEMENT

The U.S. automotive industry did not seriously consider metrication until the 1960s. In 1963 Ford's European subsidiaries dual dimensioned the engineering blueprints for a car for possible production in Europe and the United States. A Ford official told us, however, that the car was never produced in the United States.

In 1965, after the United Kingdom adopted a policy of converting to the metric system, Ford began converting its British operations. Ford's European operations officially adopted the metric system in October 1970.

In the fall of 1970, Ford's Mercury dealers introduced the Capri, a metric import designed by Ford of Europe and assembled in West Germany with the components manufactured in both West Germany and the United Kingdom. It was the first metric vehicle sold by Ford in the United States. About the same time, Ford introduced the Pinto, a customary car except for its European-built metric engine. Ford was the first automaker to produce a metric engine in this country when it began making the Pinto metric engine in the United States in 1973.

Also in 1973 Ford established a metrication planning committee to plan for a transition to metric. One year later Ford adopted a policy of converting to the metric system.

Chrysler Corporation also became involved with metrication in 1965 when its United Kingdom subsidiary began converting as a result of that country's decision to convert. Chrysler's exposure to metrics in the United States intensified from 1968 to 1973. In those years Chrysler assisted the National Bureau of Standards in preparing its study questionnaires and participated in various other metric planning activities and programs sponsored by national groups, such as the American National Standards Institute. In November 1973 Chrysler adopted a policy of converting to the metric system.

GM first studied the potential effect of metrication on its operations in 1966. It considered the study confidential and would not release it to us. GM officials would not tell us the cost estimates developed during the study; however, they did discuss certain aspects of the study. The study team concluded that conversion would increase costs substantially and would not be in the best interests of the corporation. A GM official told us that because the study team was not familiar with metrication, they estimated that practically everything in the corporation would have to be "hard" converted. The team felt every employee would need at least 16

hours of training in metrics and that GM would have to change the sizes of paper, file cabinets, and office and production equipment.

GM first experienced metrication in 1967 when its British subsidiary began converting pursuant to the United Kingdom's decision to go metric. In the same year GM's Buick Division began importing the Opel car which had been metrically designed by its subsidiary Adam Opel AG of Germany. Since then GM has continued to sell and service the Opel in the United States. Acceptance of the Opel by U.S. car buyers proved to GM that there was no critical consumer resistance to metrically designed and manufactured cars. A GM official told us that the measurement system used has no affect on car sales; consequently, increased sales is not a benefit expected from metrication.

Metrication was next studied by GM in 1970 as part of the NBS study effort. NBS asked GM to represent the automobile manufacturing industry and study the possible effects of a metric conversion on the industry. GM selected its Buick Motor Division for the study because it included all aspects of automobile production. It subsequently verified the study findings at two other GM divisions. In December 1970 GM reported to NBS that metric conversion would cost the corporation about 67 percent less than estimated in 1966.

In March 1972 GM studied whether its worldwide operations--including the United States--should convert to the metric system. A GM task force visited facilities in the United States, the United Kingdom, and West Germany. They reviewed metric conversion programs at a British subsidiary which was producing a predominantly metric passenger car. Subsidiary officials reported that the only problem encountered was assuring that suppliers could provide parts and materials necessary to sustain metric production.

In September 1972 GM established a metric planning group to determine if a rotary engine under study should be made in metric or customary measurements. In January 1973 the group's results were given to GM's Product Policy Group which included the Vice Chairman of the Board and the President of the Corporation. The study team estimated that only $9,000 of the $100 million cost of the rotary engine could be attributed to metrication. A GM official told us that the $9,000 would be needed to convert existing drawings and to replace some machine and perishable tools.

It is important to note the extent of metrication GM proposed for the rotary engine. It planned to use metric screw threads, convert existing drawings, and convert gauges

and measuring equipment to read in metric. It did not plan to change the physical size of components or accessories, such as oil filters, carburetors, and alternators. Existing machines and tools were not required to be dimensioned in metric.

GM decided in January 1973 to convert its U.S. operations to the metric system and was the first in its industry to make such a decision.

American Motors Corporation began studying the adoption of a metric policy in October 1973--10 months after GM had announced its policy. About 1 year later American Motors decided to convert and issued policy and guidelines to implement conversion.

It should be noted that in 1973 and 1974 when the automobile manufacturers made their decisions to convert, it appeared national legislation would be passed providing for a predominantly metric America within 10 years.

CONVERSION STATUS: TODAY AND TOMORROW

The automotive industry--led by GM--is following a planned approach to metrication. Except for American Motors, automobile manufacturers are producing some metric components for certain 1978-model-year cars. According to industry estimates, the biggest automobile manufacturers' passenger cars should be predominantly metric by the early 1990s.

Metric policy and implementation

Top management at each of the four U.S. automobile firms has adopted policies which provide direction and assign responsibility for implementation at the operating level. The pattern was established by GM and is being followed by the rest of the industry.

When GM announced its policy to convert, it noted that the rate of implementation would be governed by the introduction of significantly new automobile parts. The policy included the following guidelines:

--Items being initiated for development will be metric from the start.

--Items already under development will be converted to metric terms well in advance of completion.

--In-production and service items will remain as is.

--Supplier coordination should be implemented as required.

--Capital equipment with dual measuring capability should be purchased as needed.

Two years later, in January 1975, corporate management revised this policy by adding provisions that (1) each division was to maintain a conversion schedule adequate to support new product programs, (2) metric standards were to be implemented as needed, and (3) key personnel were to begin their training. In addition, each GM general manager or staff head was to appoint a coordinator responsible to report back to him but with authority to organize the conversion. Realizing that deviations from the guidelines might be necessary, all exceptions were to be reviewed and approved by GM's full-time metric planning staff.

GM officials told us that its policy means that nonautomotive operations, like the GMC Truck and Coach Division (trucks, buses, and motor homes), Electro-Motive Division (diesel locomotives and engines), TEREX Division (heavy-duty equipment), and Frigidaire Division (household appliances), will not be required to meet the same metric target date as the car divisions. Design changes in these other products occur less often than in automobiles. Consequently, although all divisions must convert, the conversion periods for nonautomotive products will be longer than for automobiles.

All four automobile manufacturers have kept metrication within existing management structures as much as possible and at the operating levels to promote initiative and ingenuity. The metrication programs are managed through corporate-wide systems of metric coordinators. At GM these coordinators may be appointed, if necessary, at various operating levels. For example, a division could also form a metric conversion subcommittee consisting of metric coordinators at the plant levels.

GM has also tried to foster corporate-wide coordination by having metric coordinators for each of its 10 operating groups. (Groups are made up of divisions; e.g., automobile divisions are part of GM's Car and Truck Group.) The metric coordinators represent the groups on a corporate-level metric council. The council allows for the interchange of metric ideas and experiences and provides a uniform approach to metrication. It also functions to resolve metrication problems and monitor the progress of the overall corporate program.

GM officials told us that few problems reach the metric council because they have been handled in the divisions. We

were told that the council has been able to resolve all but one problem and it was forwarded to GM's highest policy group. The problem concerned metric tools for skilled tradesmen and was resolved with the United Auto Workers at the bargaining table. This matter is discussed later in this chapter.

GM has a full-time corporate metric planning staff responsible for preparing and maintaining the corporation's metric manual, participating in metric planning and policy-making, working with divisions on problems and with division metric coordinators to resolve metric problems or concerns, and acting as an external liaison. Any deviations from overall corporate metric guidelines must be reviewed by this body to determine the effect on the corporation's overall metric program.

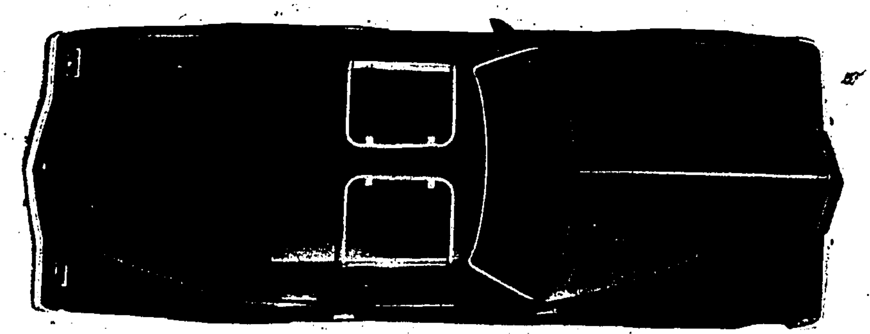
Industry's approach and goals

The four automobile companies were generally emphasizing metric in new product designs and phasing out customary products through normal obsolescence cycles. They believed that this approach would minimize costs. But, because automobile manufacturers (1) had different product lines, (2) designed new products at different time intervals, and (3) had different commitments and approaches to metrication, they had different timetables when they expected their passenger cars to be predominantly metric.

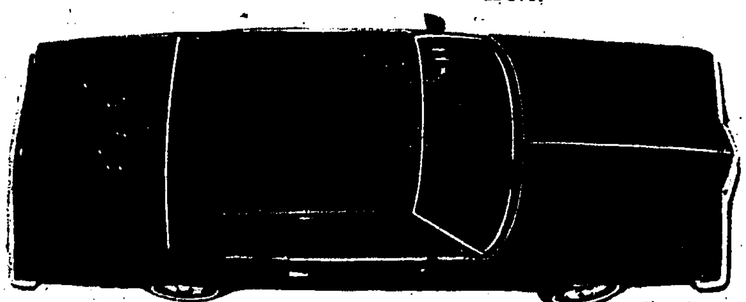
GM believed it would achieve substantial conversion by 1982; Chrysler, by the late 1980s; and American Motors and Ford, by the early 1990s. Corporate timetables for being predominantly metric generally pertained to passenger cars. None of the manufacturers we talked to had set timetables or goals when trucks, vans, or buses, or other products would be hard converted. Companies will convert these products at a much slower pace because design changes occur less frequently than for passenger cars. However, GM planned to consider trucks and buses as being predominantly metric by 1982 even if only a soft conversion is made. As for nonautomotive products, GM said that the rate of change would depend on consumer demand.

Metrication was being implemented through GM's commitment to make cars smaller (downsizing), lighter, and more fuel-efficient. One official said that the energy crisis and the ensuing demand for smaller, more fuel-efficient cars spurred the company's metric program in that more cars are being totally redesigned than otherwise would have occurred. GM's downsizing and redesigning efforts were unmatched in the industry.

According to officials, GM's new 1977 full-size cars average 700 pounds lighter than comparable 1976 models. One industry magazine stated that GM's 1978 intermediate cars have been downsized up to 12 inches, and weights have been reduced up to 975 pounds. The following illustration shows the extent of a downsizing effort.



The 1978 version shown below is 16.9 inches shorter, 689 pounds lighter, and 5 inches narrower than the 1977 version shown above.



Current conversion efforts within the industry

As a result of its downsizing program, GM had converted more automobile products by model year 1978 than any other automobile manufacturer. Metrication had occurred throughout its lines of cars--from minicars to full-size models. GM stated that its 1977 full-size passenger cars were about 40 percent metrically dimensioned. The 1978 intermediate cars produced by the Chevrolet, Oldsmobile, and Pontiac Divisions were also partially metric.

Emphasis has been on car bodies designed in metric with metric fasteners. Many GM automobile components, like engines, brakes, transmissions, and rear axles, are carry-over parts and will remain in customary units for the time being. A GM official said that to his knowledge other automobile companies were focusing on converting components like the car engine and not the car body as GM was doing.[5] GM also said that it had hundreds of metric parts, such as headlamps, fuel tank caps, thermostats, and rack and pinion steering units, in or released for metric production. It planned by 1982 to soft convert any car parts not redesigned in metric by that time.

Ford Motor Company produced a metric engine for two of its automobiles. It had two new subcompact models which it estimated were about 25 percent metric--mostly in the chassis. Ford also markets a metrically dimensioned imported car made in West Germany. During its 1978 model year, Ford introduced the industry's first domestically produced metric large heavy-duty truck which it said was about 50 percent metric. The engine and the transmission will remain customary. However, in its sales literature, Ford was expressing all 1978 metric engine displacements in liters only. Customary engine displacements were expressed in liters followed by the cubic inch equivalents shown in parenthesis.

Chrysler was producing two metric front-wheel-drive subcompacts for model year 1978--the Horizon and the Omni. These subcompacts represented the first major metric program Chrysler had undertaken in the United States. These cars had "1.7 litre" engines imported from West Germany. Chrysler planned to produce a metric engine in the United States.

American Motors officials told us that the company was not adding additional metric products in 1978. Officials said, however, that a line of metric subcompacts was planned for the future. One official said that American Motors purchased many automotive components from its competitors--mostly from GM--and that several of these components were metric. For example, GM supplied American Motors with a metric steering wheel, and Ford furnished a metric carburetor.

Metric cars sold in the United States

The sale of metrically designed automobiles and parts in the United States is not new. All four domestic automobile companies have sold metric cars or cars with metric engines which have been manufactured in metric nations. Some examples are: Opels by GM, Capris by Ford, Colts and Arrows by Chrysler, and Gremlins by American Motors. The first car to be predominantly engineered in metric and manufactured in

the United States was the Chevrolet Chevette introduced in the fall of 1975 (model year 1976), shown below.

1978 CHEVROLET CHEVETTE

According to a GM official, the energy crisis starting around October 1973 caused GM to accelerate its plans for introducing a minicar to compete with the small imports and meet the U.S. market demand for a more fuel-efficient car. Early in 1974 GM concluded that its West German subsidiary, Adam Opel AG, already had designed the type of car urgently needed in the United States. GM brought the basic design of this metric car to the United States and modified it for production as the Chevette.

Officials of the Chevrolet Motor Divison said that they did not encounter any engineering or production problems that could be related to the use of metric measurements. That is not to say there were no problems, however. Working with Brazilian and West German engineering drawings, GM had to (1) translate the foreign languages on the drawings to English, (2) redraw them to U.S. drafting standards, and (3) specify all materials, coatings, and performance and test specifications in domestic specifications. In addition, other changes had to be made, such as modifying the design to accommodate U.S. motor vehicle safety standards and emission regulations.

RATIONALE FOR CONVERSION

The automotive industry essentially sees metrication as inevitable. One GM spokesperson told us there is no longer an "if" about metrics, only a "when." He said Canada, the United Kingdom, and other countries which had used the customary system had begun converting to the metric system, and this leaves the United States as the only major nation using the customary system. The spokesperson said that some people might wonder why those involved in international trade cannot operate in metrics without changing the entire United States. He believed this would be possible, but would mean maintaining an inefficient dual-measurement system which would cause confusion and add an unnecessary burden to our educational system. Adding to the aura of inevitability, in our opinion, were the events leading up to and including the passage of the Metric Conversion Act of 1975.

GM's competitors said a key reason for their conversion is GM's conversion. Because GM is the recognized leader of the industry, its decisions and actions are followed by the other automobile manufacturers and the ensuing competitive pressure is felt throughout the automotive industry. For example, as automotive parts suppliers received more and more metric orders from GM, metric parts would become the biggest part of their business. GM's competitors--who use many of these suppliers--did not want to pay a premium price for customary parts.

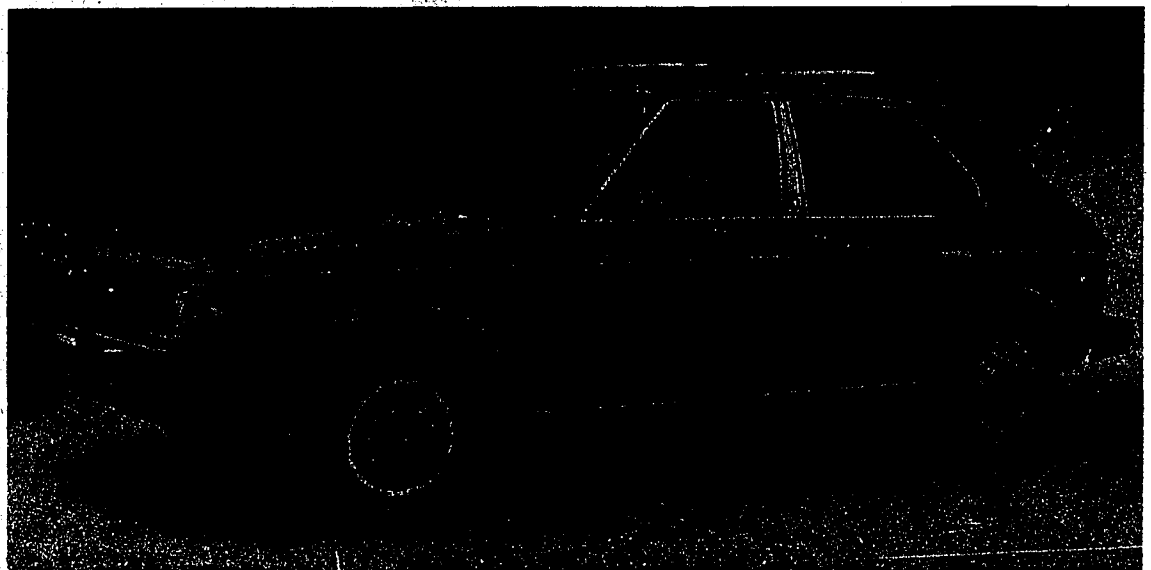
Benefits of conversion

The automobile manufacturers claimed that using one measurement system throughout their global operations would benefit them by improving intercorporate communication and dealings and increasing efficiency in designing, manufacturing, and marketing. The manufacturers see benefits through improved worldwide communication on engineering drawings, use of uniform standards worldwide, and greater designing flexibility in products. Their manufacturing operations would benefit because of worldwide availability of materials and components, easier computations, and reduced inventory quantities and costs. From a marketing perspective, conversion would allow them to meet future Common Market requirements for metric labeling on products and encourage acceptance of their products in other countries. Another benefit often cited is the sort of "housecleaning" that accompanies important changes. Metrication may help in the elimination of duplicate equipment and unnecessary procedures and increase standardization.

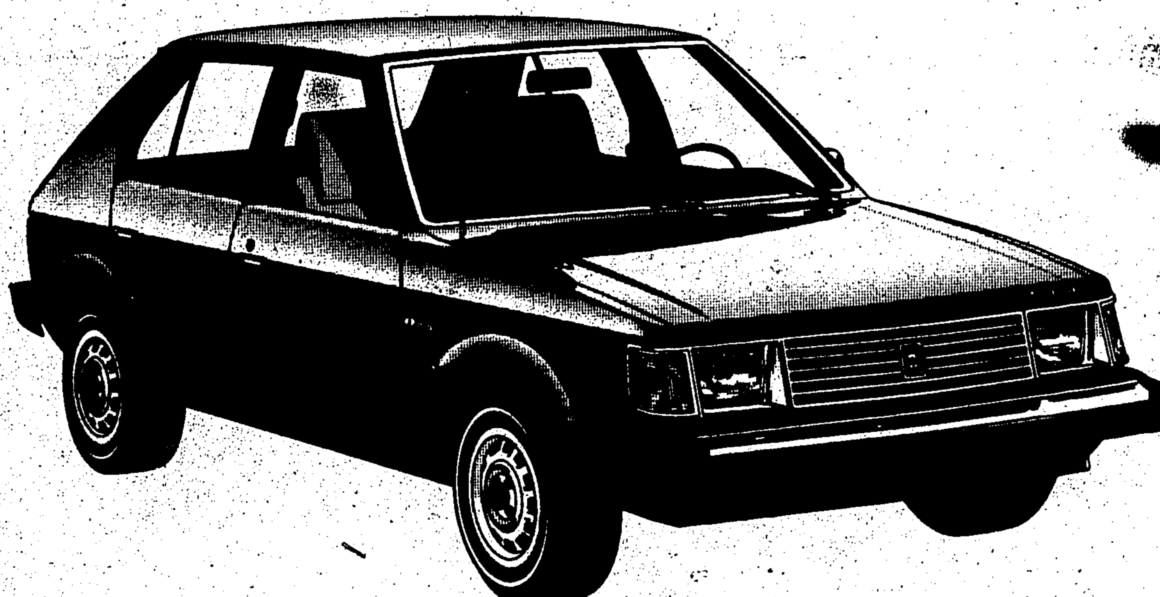
Chrysler, Ford, and GM say metrication would provide them an opportunity for marketing "world cars." A world car is one that can be manufactured or assembled and marketed throughout their worldwide operations because its basic configuration is the same.

For GM the Chevette is its world car. Chevettes are produced or assembled in Argentina, Australia, Brazil, Malaysia, the United Kingdom, and West Germany. Licensed associates of GM also produce their own versions of the Chevette in Japan, the Philippines, and Thailand. A top GM executive has said that the concept of a world car (1) offers potential for a more efficient use of plants and personnel and (2) provides the flexibility of using supplier sources around the world regardless of where the cars are finally assembled.

Chrysler's two 1978 model year subcompacts--the Omni and the Horizon shown on the following page--are the closest models the company has to a world car. Chrysler used metric units in designing these cars and found it quite beneficial because the development was a joint U.S. and European effort. According to a Chrysler metric official, the use of metrics resulted in easier engineering and manufacturing communication. Chrysler technicians and engineers from two continents pooled their ideas and efforts in a more productive fashion than if two measurement systems had been used. Although the European version of the new subcompact will be marketed with a different engine and suspension than the American version, Chrysler will be able to use various parts from around the world and produce the car in different countries with more ease.

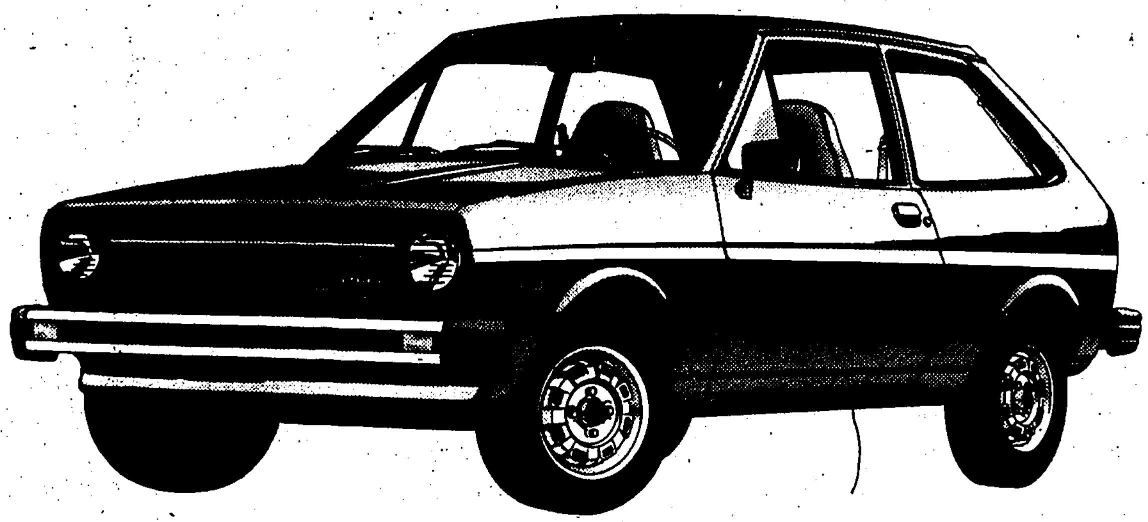


1978 PLYMOUTH HORIZON



1978 DODGE OMNI

According to a Ford official, its new import--the Fiesta which is illustrated below--is the closest thing Ford has to a world car. The car is made in West Germany, Spain, and the United Kingdom.



1978 FORD FIESTA

Cost of conversion

A Chrysler official said that metrication costs are often virtually impossible to measure accurately, yet some people persist in trying to precisely predict this cost. He said that many costs are intangible, such as productivity decreases and duplication and the errors resulting from working with a new measurement system. Another official said experience has shown that trying to measure the costs of metrication has been counterproductive. We are not aware of any conversion cost studies made by Ford.

Only GM has tried to perform indepth metrication cost studies. Between 1966 and 1973 GM performed a number of such studies, none of which were made available for our review. GM officials, however, did discuss the various issues they studied and the cost estimates for some of the conversion elements.

GM's initial study in 1966 concluded that metrication would cost an enormous sum of money; but according to officials, that study was an overreaction to the problem. For

example, it estimated that an average of about $2,000 would be needed to change every feedscrew on all production machines. The study, however, did not consider alternatives, such as (1) postponing changes until the equipment became obsolete and then replacing the old equipment with metric equipment, (2) modifying the dials of existing machines rather than replacing the entire machine, or (3) purchasing dual readout capability for existing machines which could cost $3,000 a machine but would be offset by increases to productivity. Subsequent GM studies substantiated that as more metrication experience is gained, conversion cost estimates decrease. One official told us in November 1976 that GM had concluded that its costs would actually amount to 3 to 4 percent of the first estimate made in 1966. However, he would not provide us data on the actual costs involved. Another official has been quoted as saying that GM's metric costs may amount to about 1 percent of 1 year's gross annual sales spread over 10 years.

Although American Motors has not made an indepth study, it has considered the cost impact of metrication in certain isolated instances. In 1974, for example, American Motors estimated it would cost over $350,000 to provide metric hand tools and about $625,000 to rework or replace small plant tools at 11 of its manufacturing activities. A company official said that both estimates assumed a 10-year conversion period.

A common first reaction to metrication is that it would be a costly process. A Chrysler official said that it is important to manage metrication costs as opposed to trying to calculate total costs and benefits in precise dollar terms. He added that proper cost management can reduce costs significantly with costs ending up to be much less than initially anticipated, as GM has found. This official also said that he believed metrication costs should fall within the range of normal change and development costs. What has to be remembered, according to this official, is that metrication costs are incurred only once, while benefits are cumulative and should ultimately offset any costs incurred.

The automobile manufacturers generally have adopted the philosophy that there should be no budget relief for metrication. This means managers were expected to gradually implement metrication plans and priorities within existing budgets.

GM has been able to minimize metrication costs by having conversion actions coincide with the development of new products. In this way the metrication pace is influenced by the normal cycles of equipment and facility replacement. Except for the costs to convert tool rooms, model development shops, and drafting rooms when designing and remodeling its products,

GM officials believed that metrication had proceeded without noticeable cost.

When converting existing capital equipment to metric, GM has tried also to improve the efficiency of the equipment. When efficiency was improved, most of the conversion expense was considered a capital improvement rather than a metrication cost. If GM purchased new capital equipment with only metric capability, none of the expense was charged to metrication.

As far as we could determine, no company had established a complete accounting system to record the costs associated with metrication. One automotive official told us that the cost of accounting for metrication cost was an added luxury his company would be reluctant to incur, especially when the company was losing money.

Each GM division was responsible for achieving the metric policy goals at minimum cost. For some divisions we were told metrication costs have been so insignificant that it would cost more than its worth to account for these costs.

We were told that GM accounts for only those expenditures which can be clearly identified as resulting from metrication; e.g., the cost of modifying existing plant and equipment for metric purposes. Other automobile manufacturers generally did not account for metrication costs. Officials pointed out that GM's cost experience, coupled with the fact that metrication was inevitable, showed little would be gained by studying and accounting for conversion costs. One Chrysler official told us that even if his company knew the costs of going metric, it would not alter the company's decision to convert. He said that because the automobile business is dynamic and continually changing its products, the introduction of metrics with significantly new products should keep costs to a minimum.

EFFECTS OF METRICATION

To better understand the impact of metrication on the automotive industry we looked at the following aspects.

Procurement and suppliers

The automobile manufacturers buy goods and services from some 80,000 or more firms. GM alone has over 47,000 suppliers. Several large suppliers that we visited had some experience with metrication before 1973 but had not adopted a policy until the automobile manufacturers did during 1973 and 1974. Suppliers said that, to stay in business, they must make

the product in metric dimensions if that is what automobile manufacturers want.

Surveys of supplier capabilities

Surveys by the four automobile manufacturers showed that suppliers were involved with conversion in varying degrees. Some examples follow.

GM sent a letter to its 47,000 suppliers in October 1973 stating it was committed to using the metric system. The rate of implementation would depend on the introduction of new parts and the supplier's ability to make metric products. GM said suppliers responded favorably to metrication and that giving them ample time to prepare for new model changes was essential to minimize cost increases or delivery delays. Suppliers had access to GM's metric engineering, drafting, and testing standards as well as its metric education program.

Ford began notifying fastener suppliers in 1969 that it needed metric fasteners for a metric engine it was thinking of building in the United States. A company metric official said that about half of those contacted at that time were reluctant to bid on metric fasteners, probably because they were unfamiliar with metric units. In 1975 Ford surveyed its suppliers to determine whether they could furnish metric products for 1978 models and, if so, whether Ford would incur any additional cost. The majority said that they could provide the products at minimal cost increases.

Another Ford survey showed that suppliers could furnish metric cabs for heavy duty trucks at no additional cost. However, Ford surveyed truck owners and found that they did not want metric fasteners in the truck because metric fasteners might not be readily available throughout the United States.

Status of supplier conversion efforts

Officials of three of the largest automotive suppliers told us their companies had the capability of filling metric orders because they had converted the necessary production facilities.

One supplier official commented that the automobile manufacturers were not converting as quickly as initially expected and that his company might have spent money earlier than necessary anticipating the conversion. He said he would have preferred that the automobile manufacturers notify his firm of the delay in their initial metrication schedules for purchasing metric components.

Some small- and medium-size suppliers have received some dual-dimensioned parts drawings from the automobile manufacturers. When they received drawings showing only metric units, they converted these to customary measurements for production purposes, making it unnecessary to convert equipment or train employees.

None of the suppliers we interviewed had established a date by which company operations would be predominantly metric. Suppliers will proceed at the pace demanded by their customers. As a general rule, suppliers planned to convert only the operations and equipment necessary to meet customer demand, rather than convert their entire operations to metric. Suppliers told us that once metric orders are predominant, a decision to convert the entire company may be warranted.

Small suppliers saw no benefits for themselves in converting to the metric system. The only reason for converting would be to retain the business of the automobile manufacturers. The large suppliers which are multinationals told us that they expect to receive one or more of the following benefits: (1) maintain sales and profitability, (2) enhance worldwide communication in the technical areas, such as engineering and manufacturing, and (3) reduce the size of inventories.

Purchasing documentation

Currently, GM's purchase orders, invoices, bills of lading, and other administrative documents show measurements in customary and metric units with one exception. GM's Fisher Body Division orders steel and aluminum only in metric units. The orders specify the metal thickness and width in millimeters and the quantity ordered either in metric tonnes or in kilograms. Suppliers were required to return certain information, in both metric and customary units, to Fisher Body. For example, shipping notices and invoices must show the actual weight of the shipment in pounds as well as kilograms.

Ford's documentation may be expressed in customary units, metric units, or both, depending on the part and supplier. Generally, Ford asks that shipping documentation from suppliers be returned in the same units as sent out.

Chrysler provided suppliers with customary or dual measurement purchase orders, drawings, and materials specifications. Metric units by themselves were not used because Chrysler did not want to inconvenience vendors who might have problems working only in metrics. According to a company official, the use of dual specifications gave vendors

the flexibility to handle Chrysler's purchase orders either way. Chrysler asked that shipping documentation coming back from suppliers be in customary measurements.

An American Motors official told us that, although American Motors had yet to convert the information on purchase orders, material specifications, invoices, or other administrative documents, it did not anticipate any supplier problems.

Metrication at dealerships

Automobile dealers have been involved to some extent in the sale and service of metric cars--either imported or domestic. Though the dealers were aware of the ongoing metric conversion in the automotive industry, they had not begun active metrication programs. The dealers we visited had developed no metric policies or plans for converting their services, sales, and administrative operations. Nor had the National Auto Dealers Association considered the issue of metrication. Most dealers believed metrication had not affected consumer buying decisions or car sales so far.

In March 1976, however, GM's Marketing Staff cautioned dealers to begin preparing to convert so they could service metric cars. It suggested that dealers acquire metric tools and build up inventories of metric nuts and bolts--fasteners. GM stated that some non-SI-metric tools now available for use on imported cars would not work properly on parts designed to SI-metric standards. Concerned that service technicians might inadvertantly mix metric and customary fasteners, which could result in vehicle damage or malfunction or personal injury, the Chevrolet Motor Division notified all its dealers in November 1975 about the special service requirements for the 1976 Chevette due to the use of both metric and inch-type fasteners on this vehicle.

Most GM dealers saw metrication as just one of the many changes GM makes and not as a big problem. Dealer representatives told us that they had the capability to sell and service the metrically designed cars produced by GM. In their opinion, although metrication had not affected consumer buying decisions or sales of cars so far, they expected problems in the future. They believed that there would be increased expense for metric parts, labor, and operating costs. GM dealership personnel we interviewed generally said that cost increases would ultimately be passed on to the consumer. However, these dealers indicated that they hoped to keep costs down by converting only where and when necessary.

None of the other manufacturers' dealers we interviewed could cite any short-term benefits to their operations from metric conversion. Several felt metrication may cause more standardization of parts and fasteners in the long run, which would ultimately decrease the size of inventories. Some expressed the opinion that the metric system would be easier to use. While metrication was not expected to cause dealers major problems, consumer costs for customer services are likely to increase in the areas of labor, parts, and inventory.

Impact on mechanics

The principal impact on mechanics may be the productivity lost from not being able to readily distinguish metric from customary parts and fasteners, and mechanics' requirements for metric hand tools.

Most of the dealers we interviewed believed that metrication had affected or would affect the productivity of mechanics during the beginning of the conversion period. Several mechanics said that they had experienced problems in identifying metric from customary tools and fasteners. This agrees with the 1971 NBS study indicating some concern on labor's behalf that mechanics unfamiliar with metric tools work more slowly and less surely and are therefore less productive for awhile. Several dealers said that any increase in cost resulting from productivity decreases would result in higher service charges to consumers.

Dealership mechanics are generally required to purchase their own hand tools. Mechanics we talked with had investments of $35 to $350 in metric tools and $3,000 to $7,500 in other tools. Several mechanics could not estimate what their future investment in metric hand tools would be, but others estimated that they would need to invest up to $300 for metric tools. However, an official of the United Auto Workers Union estimated that metrication would cost mechanics an additional $1,000 to $1,500 for tools and tool boxes. One dealership manager told us that future wages of their mechanics probably would reflect any additional costs of metric tools.

According to an official with the Hand Tool Institute, a trade association which represents the hand tool industry, many manufacturers of hand tools have the impression that metric conversion is mandatory within a 10-year time period. Consequently, domestic tool manufacturers have begun to produce metric tools even though industry standards have not been developed.

Mechanics generally agreed that metric tools are available. Some may be more expensive than customary tools. We

examined the prices of metric tools at a main source for mechanics tools and found that 15 of the 22 metric tool sets sold for the same price as comparable standard tool sets, 4 were more expensive, and 3 were less expensive. If the tools in the 15 sets that had identical prices were purchased individually, in eight instances the metric tools were up to 17-percent more expensive than comparable standards tools; in five cases, up to 27-percent cheaper; and in two cases, equal.

Automobile manufacturers have taken steps to assist dealership mechanics in getting necessary metric tools. For example:

--Chrysler Corporation will furnish mechanics all the necessary tools to serve the imported metric Colt and Arrow for a cost of $89, which is lower than a comparable set of tools from a tool supplier.

--GM has arranged with an independent tool manufacturer to provide a metric wrench set to mechanics, through the dealership, at a discounted price.

--The Cadillac Division notified dealership mechanics exactly what size wrenches and sockets were needed to service 1977 Cadillacs. The cost of these necessary tools was less than $50.

--Chrysler and GM have also prepared, but had not yet distributed, a list of basic metric tools so that dealership mechanics are informed of their future metric tool needs.

--Ford Motor Company's own line of tools offers metric tools at discounted prices to dealership mechanics.

Inventories of parts and fasteners

Dealership managers did not agree as to whether most metric parts and fasteners needed were readily available. A GM official responsible for working with dealerships told us that one product dealers would probably have difficulty in acquiring is the 6.3-millimeter (1/4-inch) fastener. He said that this fastener is only used by GM in the United States, and most domestic fastener suppliers buy their metric fasteners from foreign manufacturers where the 6.3-size is not used. Although few purchases of metric fasteners had been made, many managers agreed that some parts were more expensive than comparable customary parts and fasteners. The Parts Manager at one GM dealership said that metric fasteners are more than twice the cost of customary fasteners. The GM official referred to above agreed that in some cases metric

fasteners may be more expensive. Several dealerships told us that consumers will pay for any added cost.

Dealership inventories are extensive. For example:

--Chrysler currently uses about 150,000 different parts in its cars.

--Each car has more than 15,000 parts.

--Inventories are maintained for 6 or more years on most parts.

--There are approximately 3,500 fasteners in each car.

Dealers generally said that metrication had not affected inventory costs to date. Current investment in parts and fasteners at three of the dealerships we visited ranged from $80,000 to $150,000. An American Motors dealership expected its inventory of spare parts and fasteners to increase by $15,000 to $20,000 (19 to 22 percent) due to metrication. One GM dealer predicted that small dealerships would encounter various cash flow problems if forced to tie up additional working capital in spare parts inventories.

A Chrysler official said that metrication was expected to require slightly larger inventories for 8 to 12 years because dual inventories would be needed until customary parts were phased out. With the increase in the number of parts, dealers' space requirements may also increase. This official also said that in the long run, metrication should result in fewer parts being needed. One Ford dealer told us that his cost of acquiring parts inventories may increase because the change to metrics may require costly changes in his computerized ordering system.

Employee training and tools

Metrication affects automobile manufacturers' employees in several ways. Perhaps the two most significant are the training needed to understand metric measurements and the cost of metric hand tools.

The industry position on training employees in the metric system is patterned after GM--train only those employees who need to know, in what they need to know, and immediately before they need to know it. GM estimated that only about 15 percent of its employees would require any formal metric training and that only a few of those would require more than simple instruction on linear measurement. For the large majority of employees who were not directly affected by

metrication, GM's metric staff has distributed only metric posters and booklets.

GM developed a comprehensive training program in 1973. Its competitors have since recognized the need for such a program. They worked through the Motor Vehicle Manufacturers Association and a consulting firm to develop a metric training package--much like the GM program--which is now being used by automotive suppliers and firms in other industries. In one of GM's initial training experiences, employees reacted negatively to training until they became more familiar working with the metric units, which took about 6 to 7 months. At one facility we visited, GM was trying to increase employee awareness of metrics by installing speed signs, bridge clearance signs, and temperature displays in metric units. Some GM facilities had metric weight scales and height gauges so employees could weigh and measure themselves in metric units.

One of the industry's major concerns involving employees was the question of who would pay for metric hand tools. The Motor Vehicle Manufacturers Association opposes Government subsidies for metric conversion, although it recognizes that special consideration may be needed for certain problem areas. GM endorses this position and readily admits that some small businesses may be economically disadvantaged. According to GM, tax provisions and employer practices already provide mechanisms for workers to recover some metrication costs. For example, skilled trades workers under the Union contract with GM could acquire from the corporation the metric tools needed to do their jobs. If workers choose to buy their own metric tools, they may be able to recover a portion of this cost by taking an income tax deduction.

The United Auto Workers Union policy on metrics, adopted in 1973, was that employers assume the total costs of conversion and not transfer some of the costs to their skilled workers. The automobile companies were making necessary metric tools available to skilled trade employees. According to a Union official, there had been no grievances regarding metric tools, probably because metrication was just beginning. As momentum increases, however, the official told us that the Union expected to take a stronger bargaining position to protect its skilled workers.

Inventories and identification of metric items

Automobile manufacturers will maintain dual inventories for many years before customary parts are completely eliminated. In addition, they will likely incur some costs for identifying metric and customary parts to minimize mixups.

GM officials told us that they expected to maintain dual inventories for 12 or more years. The company was already maintaining a dual inventory for fasteners. In the long run, GM believed it would achieve an overall reduction in its fastener inventory because it expected to reduce the number of different sizes.

Ford Motor Company believed that it may have to maintain customary and metric parts into the next century. Chrysler expected to have larger inventories for at least the next 8 to 12 years. American Motors was not in a position to determine how long it would have to maintain dual inventories.

One method for identifying and controlling a dual inventory is color coding--one color for metric parts, another for customary. Although some GM divisons used this method, not all divisions agreed that color coding was good policy. GM told us that color coding may not be as beneficial as it initially believed it would be. At its subsidiary operation in the United Kingdom, for example, GM color coded its metric parts and fasteners with a zinc dye which acted as a lubricant and caused the metric fasteners to come loose or unscrew too easily.

The original intention for color coding was to avoid assembly line worker confusion. However, according to a GM official, U.S. production line workers have experienced no problems in identifying customary from metric fasteners because they worked with fasteners according to the part number, not by color. Color-coded fasteners also were not designed to help service mechanics distinguish between a metric and customary fastener. The color usually wears off a fastener after about 5,000 miles of driving, according to a company official.

If used for all fasteners, GM's practice of color coding could be expensive when one considers GM uses an estimated 20 billion fasteners (nuts and bolts) per year--about 3,500 in each automobile. A top executive with one fastener manufacturer selling to GM told us that his company has had increases in its production costs of about 8 percent because of the cost of blue paint needed to color fasteners for GM. This executive said that his company sells fasteners by the pound with the average price per pound being about 50 cents. He said that GM was paying about 4 cents per pound extra due to the coloring requirement. He also said his competitors have had to incur the same cost.

Other examples of how GM identifies metric inventory existed at its Chevette engine plant. Since the plant had an assembly line for the Chevette metric engine and another for

customary V-8 engines, certain steps were taken to avoid mixups. First, metric parts were stored in tubs painted green to match the Chevette engine assembly line. Customary parts were stored in blue-colored tubs. Second, all incoming shipments of metric parts were labeled with a preprinted "metric" label. Other techniques used were to (1) have all vendors stamp a permanent metric marking on tool shanks and (2) either color code certain parts, such as the cylinder head valve key, or use special markings on the part to help identify it.

Ford had a similar situation in that its plant producing the "2.3 litre" metric engines for the Mustang II and Pinto cars also produced other engines using customary parts and fasteners. Ford avoided the potential problem of mixing parts and tools by (1) locating the metric engine operations in a separate area of the plant away from the customary engine operations, (2) stamping or etching metric fasteners and tools with the letter "M" or the word metric, and (3) color coding all metric gauges yellow. Ford said the separation of metric and customary operations was a contributing factor to what it termed a successful metric changeover at the engine plant.

Engineering standards and drawings

Automobile manufacturers have yet to develop accepted industrywide metric engineering standards or practices. Manufacturers generally were developing their own which had been the usual practice in this industry. At GM some interim metric standards for fasteners, drafting, and materials had been developed for its U.S.-based operations. A GM official told us that certain GM overseas divisions have different metric standards than the U.S. operations. (See ch. 6 for a discussion of standards.)

Standardization of metric fasteners was GM's highest priority metric goal. It believed up to 95 percent of all metrication problems involved fasteners. For its U.S. operations, GM is using the Optimum Metric Fastener System adopted by the ANSI. However, a GM official said that this fastener system was not used by all its overseas subsidiaries. (See ch. 7 for a discussion of fasteners.)

American Motors will probably use many of the metric standards GM adopts because it has been using various GM procedures and standards for many years. Ford and Chrysler were developing their own standards for such items as fasteners, metals, tires, bearings, and drawings.

GM used conversion charts on engineering drawings (dual dimensioning), but generally encourages its engineers and other staff to discontinue using dual dimensions as soon as they are familiar with the metric units. In many instances GM believes it is practical to switch to the metric units right away.

Ford officials told us that their usual practice is not to use dual dimensions on their engineering drawings because it is costly. One Ford official estimated that less than 10 percent of the engineering drawings released for model year 1978 Ford products were solely in metric dimensions.

Chrysler's current practice is to provide conversion tables on all engineering drawings except where a specific plant or vendor indicates the chart is not required. Chrysler believed conversion charts placed on engineering drawings would result in the exact tolerances desired and would minimize costly supplier mistakes due to confusion with metric units. Chrysler planned to eliminate dual-dimension drawings by mid-1979. American Motors officials told us that the few metric drawings they had were in metric units only.

Tooling and machines

Only a small percentage of each automobile manufacturer's production tooling and machines had been converted because conversion was just beginning and metric production could be done with existing tooling and capital equipment. Ford found this out when it made its "2.3 litre" automobile engine in Ohio. Also, Chrysler officials told us that most of the production of its metric subcompacts would be done with customary tooling and machinery.

A Chevrolet plant which produces the metric engine for the Chevette has converted tool room machines, such as lathes, mills, and various types of grinders. Machines where close machining tolerance was required were modified by using digital readouts having dual-measurement scales.

According to one GM official, only 25 percent of its machine tools would require metric conversion. He explained that 50 percent of all the machine tools were not measurement sensitive and would not require conversion, and the remaining 25 percent would be replaced with metric machines as they became obsolete.

Some GM divisions opted early not to try to make special metric tools, recognizing that a metric tool was not needed to make a metric part. The components of the tools, the tool drawings, and the clamping mechanisms could be in customary

measurements, yet the part produced could be in metric dimensions.

Other GM divisions decided to make metric tools immediately. At first these divisions found that standard metric tooling components were either not available or available at a premium cost and at untimely delivery dates. They since have found they can buy what they need at little or no cost penalty as the supply lines are filled.

GM has found it important to consider that a machine may be needed to work on both customary and metric parts and that obtaining a dual capability may be desirable when purchasing new equipment. The use of digital readouts is expensive but allows the machining of parts to either metric or inch dimensions. GM has found that digital readouts increase productivity. Thus, it believed metric capability could be added at little or no net cost.

Computer systems and data bases

Automobile manufacturers have been converting their computer systems to metric. Administrative operations and engineering data bases must be converted. Converting this data involves changing technical handbooks with engineering formulas and tables and existing test results already computerized in engineering files.

Ford began converting its computer systems in 1975 but was unable to tell us what progress had been made. Chrysler also began converting its systems in 1975--mostly in connection with engineering data. Problems encountered so far include difficulties in identifying data fields affected by metric conversion and the alteration of some preprinted forms to make space for metric characters.

A GM official told us that each division is assumed to be making progress but he was not able to give us an overall estimate of progress. The official said that the Chevrolet and Pontiac Motor Divisions estimated it would take two or three people 1 or 2 years just to convert a portion of their computerized spring test calculations. We were told that one of GM's subsidiaries in the United Kingdom, after almost 1-1/2 years of work, finished converting its administrative documentation system; i.e., accounting records, purchasing, and invoicing. (See ch. 18 for discussion of the computer industry.)

Consumer information

Mechanics and consumers may not be aware that a vehicle is metrically designed and dimensioned by visual inspection alone. Therefore, they must rely on the automobile manufacturers for information about new cars.

According to a GM official, service manuals for new cars were dual dimensioned if most of the car was metric. If only a few parts were metric the service manual showed dual dimensions only for the converted parts. An official at Chrysler said that the metric content of its service manuals consisted of some dual tables and conversion charts used primarily to familiarize mechanics and service technicians with certain metric terms. He said there was no reason to make extensive use of both measurement systems because the company's 1977 cars generally were not of metric design.

The Chrysler Corporation said that the sole use of metric units in operator manuals would depend on the rate of conversion within the automotive industry and the public's knowledge of metric terms. An official said that the operator's manual for the 1978 Plymouth Horizon and Dodge Omni showed metric units followed by customary measures because these were essentially metric-dimensioned cars. However, the reverse practice was used for nonmetric cars. For example, the operator manual for the 1977 Plymouth Volare, showed the following dual information:

Item	U.S. measure	Metric measure
Cooling system pressure	16 psi	(110 kPa)
Thermostat	195° F	(90 C)
Fuel capacity	18 gal	60.6 litres
Maximum vehicle capacity	1,100 LBS	(500 kg)

The general practice at GM was to show both measurements in operators manuals if the car had a sufficient amount of metric components which warranted it. For example, the manual for the 1977 Chevrolet Monte Carlo and Vega cars showed only customary measurements because these were not considered metric cars. The manual for the predominantly metric Chevette showed both measurements as does the manual for the 1977 Chevrolet Impala, which was about 40 percent metrically dimensioned. When both measurements were used, GM's approach was to show the metric measure first followed by the customary measure in parentheses. Here are some examples from a 1977 Chevrolet owner's manual.

Item	Metric measure	U.S. measure
Gasoline tank	76.0 l	(20.0 gal)
Cooling system	17.0 l	(18 qts)
Wheel base	2,945 mm	(116.0 ")

However, GM was not consistent in its use of measurements in operators manuals. In the manual referred to above, for example, we observed that some pages showed only the customary measures; other pages showed both measures.

A certain level of inconsistency also existed in GM's sales literature. Pamphlets advertising the 1977 and 1978 Chevettes, both metric cars, expressed the cars' dimensions in customary units followed by the metric units in parentheses. This is the opposite of how similar data was shown in Chevrolet operator manuals for metric cars as illustrated above.

The practice used for showing measurements in sales literature seemed to vary from division to division. Regardless of whether a car was metric or not, advertisements for 1977 Oldsmobiles showed customary measurements alone. Literature for three 1977 Cadillac cars (only one of which could be considered metric) showed metric units followed by customary units.

The Ford Motor Company literature for most 1977 and 1978 models showed measurements in customary units. But literature for the metric-dimensioned Fiesta, for example, showed the customary units followed by the metric units.

Legislation and regulation

The metric conversion aspects of legislation and regulation will be of concern to many industries but especially to the automotive industry. The industry is highly regulated at the Federal, State, and local levels. Many of the regulations on motor vehicles, such as those involving emissions control, energy conservation, noise control, and safety, specify units of measurement.

A mutual concern for both the regulator and the regulated would be the selection of metric values that are rational replacements for the customary units. The regulator will not want to see the performance levels of standards eroded by a mere change in measurement units. Nor will the regulated want to have performance levels tightened because numbers are rounded off in the conversion process.

Using a different metric speed as a basis for conducting vehicle crash tests could have drastic effects. Crash tests are required by the National Highway Traffic Safety Administration, Department of Transportation, to prove the acceptability of new and existing car designs. If 30 miles per hour (the current testing basis) is converted to metric, it becomes 48 kilometers per hour. Several industry officials were concerned that there could be a temptation to round this figure to 50 kilometers per hour. However, the difference in energy of a barrier impact between 48 and 50 kilometers per hour is exponential and might possibly require complete reengineering of the vehicle to meet the more stringent limits.

The Motor Vehicle Manufacturers Association believed each measurement in a motor vehicle regulation would have to be examined carefully before decisions can be made to convert to realistic metric values. It also believed that regulators should avoid promulgating rules until enough expertise is developed to permit an orderly transition to metrics without causing unintentional penalties on affected parties and that changes should be coordinated with those affected.

CONCLUSIONS

Because of its influence on the U.S. economy, the automotive industry's decision to convert to the metric system is having a major impact on metrication in the United States. Many suppliers and others, such as dealers, mechanics, employees, and the public, are beginning to or should begin to feel the impact of metrication.

Suppliers to the automotive manufacturers--GM alone has about 47,000--generally are converting whatever is necessary to supply the automobile manufacturers with metric products. Most groups being affected by the automotive industry's decision to convert--e.g., suppliers, automobile dealers, mechanics, labor unions--saw no necessity to convert nor benefits to be gained. Any benefits to be gained by going metric appear to apply primarily to the automotive manufacturers and large suppliers having multinational operations.

Automobile manufacturers claimed that using one measurement system throughout their global operations would potentially offer many benefits. Potential benefits included the simplicity and convenience of having their worldwide operations use a single measurement system. Other potential benefits, like reduced inventories and increased standardization, are potential future benefits but whether these materialize remains to be seen.

Metrication will involve costs for such things as (1) equipment purchases and modifications, (2) employee training, (3) the need to stock and work with customary and metric parts, and (4) changes to computer systems. Automobile manufacturers, however, did not know what their total metrication costs would be. In an attempt to convert at minimum cost, their conversions are being carried out in conjunction with size and equipment changes that would have occurred in the normal course of their operations.

Conversion by the automobile manufacturers was purely voluntary. No timetables had been set by outside organizations for them to adhere to. They have been able to implement metrication gradually over a long period of time, train employees on a selected basis, and not make wholesale and unwarranted changes to existing facilities and equipment. Following this approach, they believed that the benefits from conversion ultimately ~~will~~ outweigh the total costs to be incurred.

The automobile manufacturers' decision to convert to the metric system appears to rest more on their conclusion that metrication in the United States is inevitable than on a definitive comparison of benefits and costs. Because of its high visibility, the automobile manufacturers' decision to convert adds to the feeling that the whole country is converting.

Several groups point to the automotive industry, particularly the multinational automobile manufacturers, as leading the way into metrication. While this may be true, some automobile manufacturers themselves were many years from becoming predominantly metric. At current timetables certain passenger cars and parts will continue to be produced under the customary measurement system into the 1990s. It is uncertain when other motor vehicles and nonautomotive products the manufacturers produce will become predominantly metric. Automobile manufacturers have made major conversion progress without Government assistance.

The automobile industry's experiences point out that the United States can function using two measurement systems. For many years metric automobiles have been sold in the United States even though the Nation is predominantly customary.

The metrication progress taking place in the automobile industry could be creating a trend toward metrication that might prove to be irreversible in the future. If this trend continues, the United States might find itself a predominantly metric country by the end of the century under the current national policy of voluntary conversion. And if this happens,

it will have been largely due to the actions of the multinational firms which seem to be the ones with the most to gain from metrication.

CHAPTER 12

METALS INDUSTRY GOING METRIC RELUCTANTLY

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The metals industry depends on the needs of its major customers--automotive, farm implement, and earthmoving equipment companies--many of which are large multinational corporations. Several large customers have announced intentions to convert their operations to the metric system and thus will eventually order metal products made to metric specifications. If the metals industry is to meet this demand, at least a partial conversion to the metric system becomes inevitable for them. Realizing this, metal producers were preparing for conversion and all the ramifications such a change would bring.

The metals industry generally believes conversion would be costly with few benefits in return. But because its largest customers plan to convert, the industry is converting reluctantly. To minimize its conversion costs, the industry initially converted only those activities necessary to meet customer needs. But metal companies are concerned that customer demands for metric products will occur too slowly and result in a prolonged transition period with two measurement systems for the industry. Industry representatives caution that a drawn-out conversion would be confusing and more expensive for the metals industry. Metal companies believe that if the United States decides metrication is necessary, a coordinated national plan must be developed and implemented.

In our review of metrication in the metals industry, we interviewed a number of officials representing major metals producing companies, metals distribution centers, industry trade associations, industry workers, American National Metric Council's Metals Sector Committee, and major users of metals. We reviewed available cost studies, industry trade statistics, industry standards, company position papers and policy statements on metrication, and metric guides and manuals.

BACKGROUND AND PAST METRIC INVOLVEMENT

Companies in the metals industry make products from iron, steel, aluminum, copper, lead, zinc, and other metals. To date, steel and aluminum companies have been the most involved with metric conversion because those metals are basic to the production of automobiles and farm equipment. The automobile industry by itself is the major customer for sheet and strip metal. Manufacturers of such metal products have been using the metric system to a limited extent in designing products and manufacturing activities for a number of years.

Iron and steel

Iron and steel products are a staple of our economy. In 1975 iron and steel companies contributed $33.7 billion, or 2.2 percent, to our gross national product.

All major iron and steel producers are members of the industry's trade association--the American Iron and Steel Institute. Until 1975 the Institute was a critic of metric conversion. For example, in Congressional hearings on March 20, 1973, the Institute stated that the industry would expend more than $2 billion over a 10-year period to convert products while receiving little benefit. This cost estimate was based on a 2-year study of the impact that conversion would have on the steel industry.

According to the study, more than 95 percent of the industry's products are sold in the United States and Canada. Thus, metric conversion would merely increase costs of serving this market. In fact, foreign steel producers probably would capture a larger share of this market because they have lower costs. Steel exports by American producers were not expected to increase from metric conversion because high labor costs generally make it difficult for U.S. producers to compete in foreign markets.

The Institute, which developed the $2 billion estimate using 1971 prices, stated that two phases of conversion would be necessary. The first phase would be the preparation--planning, training personnel, and purchasing equipment. The second would involve the transition period during which inventories would have to be maintained in both customary and metric measures. The estimate assumed the most favorable circumstances to conversion and that there would be optimum coordination of the changeover. The Institute qualified its estimate by pointing out that the estimate did not include significant additional costs that would be incurred for mining, transportation, fabrication, and related activities. Nor did it include costs to develop metric standards for the hundreds of thousands of steel products.

By November 1974 some major steel users had announced metric conversion plans, and the Congress was considering metric legislation. As a result, the Institute reversed its position. The costs of metric conversion became secondary to supplying the needs of customers.

In testimony before the House Subcommittee on Science, Research and Technology, an Institute official said:

"A change to the metric system of measurement will occur in the United States on a national basis in the foreseeable future. Major steel users, such as the automotive, earthmoving and agricultural equipment, business machine and other industries, have announced plans to convert to the SI [International System of Units] metric system of measurement. * * * This fact, more than any other, makes it inevitable that the SI metric system will eventually become the predominant system in the United States." [Underscoring supplied.]

The Institute believed a national metric policy was needed and a national metric conversion board should be established. While the Institute holds that conversion should remain voluntary, it believes timetables for achieving various phases of conversion should be a Board priority so conversion can be done in the most prompt, orderly, and economical fashion.

Aluminum

The aluminum industry had $11.4 billion of sales in 1976. Most aluminum companies belong to a trade association known as the Aluminum Association. The Association told us its members believed that adoption of the metric system was inevitable. In July 1970 most Association members recognized the metric system as one which would be easier to use and less subject to error but saw no advantage in adopting it. Instead, they saw costly problems, such as

--education and training of personnel;

--conversion of engineering drawings, technical literature, promotional material, operating documents and procedures, and reprograming of computers;

--replacement of instruments, gauges, and recorders;

--operating with a dual system during a transition period;

--errors and confusion during the transition; and

--possible premature obsolescence of capital equipment.

On the other hand, members which operated in the international markets favored metric conversion because it would eliminate for them a dual system of measurement.

Copper

The Copper Development Association Incorporated represents the copper industry. Membership includes most major mining companies, smelters and refiners, brass mills, and wire and cable mills. According to the Association, copper companies have done little in metric conversion. Although the industry favors soft conversion, it will adopt whatever measurement system becomes the accepted practice of its customers.

Early in 1974 the industry was not advancing toward metric conversion because of the lack of customer activity in that direction. But by June 1974, necessary soft conversions were being made without effort to hard convert. According to the Association, the copper industry stated that it will convert to metric sizes when it becomes essential to meeting customers' demand. As of December 1976, however, metric activity within the copper industry had been limited to only a few metric orders. The customary measurement system remains while the consensus of the industry toward metric conversion is wait and see.

Lead and zinc

Companies have no plans for metrication of most lead and zinc products. These companies are represented by two trade associations, neither of which has studied the impact of metrication on their industries nor adopted a position regarding metric conversion. The associations, however, are establishing a joint metric committee to develop a metric position.

According to a spokesperson from each of the trade associations, most companies do not favor metrication. Nor do they foresee a great deal of hard conversion for their industry, except for some lead products which are now or may soon be produced in metric units. Lead used in ammunition has been produced in metric units for years. Other products may be converted, depending on customer demand. As in the steel, aluminum, and copper industries, the timing and pace of conversion depends on customer demand.

CONVERSION STATUS: JUST BEGINNING

Metric conversion is just beginning in the steel and aluminum industries. These industries have made major progress in planning for a conversion to the metric system and in developing industrywide metric standards. Metric sales have been minimal to the disappointment of steel and aluminum companies which by now expected to have many orders for products made to metric specifications. The remainder of our

discussion on conversion status has been drawn primarily from our review at steel and aluminum companies because the copper, lead, and zinc industries have done little to date in converting to metrics.

Industry's plan and approach

Metal companies and associations have been coordinating industry conversion efforts through ANMC's Metals Sector Committee. Membership on this Committee consists of associations or individual representatives of the metals producing industry, fabricators, distributors, major metal user industries, and government agencies. In March 1977 this Committee established a conversion plan for the industry which divided the conversion process into three phases.

Phase I: Metric orders are generally acceptable for production if tooling or processing techniques are available or if quantity justifies conversion costs. Mixed unit ordering is undesirable because errors may result. Metric orders are processed in customary units. Customer documentation will be in the units specified by the customer.

Phase II: When metric orders dominate they will be produced in metric units, but documentation to the customer will be in the units he specifies.

Phase III: Customary units phased out. All orders, production, and documentation will be in metric units only. Customary unit orders will be unacceptable.

The plan does not have a timetable for implementation. The Committee believed setting dates was not within its jurisdiction because it might subject the industry to possible antitrust action. It noted, however, that other countries attempting conversion without specific schedules faced many coordination problems. Under voluntary conversion, phases I and II would be prolonged for many years and conversion would vary widely for producers and users. The Committee believed metric conversion would be unnecessarily costly, confusing, and inconvenient to all producers and users unless a national timetable were established.

Most companies in our study had metric conversion plans which generally call for converting only those products and that equipment necessary to meet customer demand. Consequently, entire production lines and machinery were not to be

scrapped. Metal companies included in our study were all in phase I.

With one exception, all companies we visited had metric committees structured at the corporate level and endorsed by top management. Most companies staffed their committees with personnel from accounting, engineering, legal, manufacturing, marketing, and computer operations departments. Metric representatives were also appointed within each department. The departmental representatives assumed metric tasks in addition to normal duties and were responsible to a metric coordinator who reports to the corporate metric committee.

Metric standards

To make a smooth and uniform changeover to the metric system, industry must agree on standard metric units and engineering practices. According to ANMC's Metals Sector Committee, such standards are needed to minimize transition cost. Work remains, but major progress had been made on getting industrywide standards.

Organizations, such as the American National Standards Institute and the American Society for Testing and Materials, had been developing metric engineering standards for the metals industry. In 1974 ANSI issued two national metric standards covering sizes of metal products. One dealt with thickness and widths of flat metal products; the other was for round, square, and hexagon metal products. Standards for tubular products--outside diameters, and wall thicknesses and lengths--had also been established except for pipe. The American Society for Testing and Materials was developing standard metric specifications for metals covering product tolerances, mechanical and physical properties, and methods of testing.

The American Iron and Steel Institute has been leading the way in developing standard metric units for the steel industry. In 1976 the Institute published a "Metric Practice Guide" for steel companies. ANMC's Metals Sector Committee, recognizing the value of having standard metric units for the entire metals industry, asked the American Society of Metals to develop a "North American Metal Industries Metric Practice Guide" which would be based on the guide for steel companies.

Metric products

Some metal companies were already producing some flat-rolled sheet steel and aluminum in metrics, primarily for their large multinational customers in the automobile industry. The industry has been able to roll sheet metal products to almost any thickness desired. As a result, metal companies

say they can sell flat-rolled sheets in preferred metric sizes at no increase in prices. Problems are expected, however, for shaped products, especially structural steel and pipe. For these products, extensive retooling may be necessary and costly.

Metal companies were beginning to publish lists of standard metric products and prices. One steel producer in 1975 published a catalog covering about 80 percent of its product lines in which metric products can now be ordered. Officials with this company said, however, that less than 1 percent of their sales were metric orders at the time of our visit in April 1977. Another firm had distributed a list of its metric prices for flat-rolled sheet products. In June 1977 an aluminum producer was the first to publish metric price lists for two automotive products.

Presently, metric products represent a very small part of the metals industry. But, ANMC's Metals Sector Committee believes 1977 was the year metrication began in earnest.

BENEFITS QUESTIONABLE

Major steel and aluminum firms see little benefit in converting to the metric system. Employment and foreign trade was not seen as increasing or decreasing. Metric orders would simply replace orders that would have been placed in customary sizes.

Some metric advocates state that one long-term benefit from metrication could be a reduction in the number of different sizes of products through increased standardization. They believed such a reduction would substantially offset the costs of converting to metrics through production and inventory economies, as well as other savings. One of the main efforts the metals industry had undertaken regarding metrication was the development of metric standards covering preferred metric sizes. The industry hopes its concept of preferred sizes reaches enough metal users so these customers would begin designing to these standards. But already several of the country's largest metal users have expressed a need for metric sizes in addition to those standards already developed. If preferred sizes are not adhered to or are continually expanding, the benefit of standardization could be lost to the metals industry. A number of metals industry officials question whether a reduction in the number of sizes will really occur or whether the situation will revert to what we have today under the customary system--a proliferation of sizes. These officials say that standardization, if feasible, could have occurred under the customary system.

The metals industry believed the only way metal users would adhere to preferred size standards would be to have better program leadership and coordination at the highest levels of Government. The U.S. Metric Board or the Congress would have to establish a national timetable for implementation and ensure that preferred metric sizes would be standard.

CONVERSION MEANS COST

Companies generally believed that metrication would be costly, both to metal producers and metal distribution centers. As previously noted, the steel industry estimated metric conversion at $2 billion. What total costs will be, however, are not known. During our review we found no cost-benefit studies made by any of the companies visited. Some believed it does not matter what the costs are because the decision has been made to convert. Tracking metric costs would just add to the cost. But being cost conscious, companies were taking the least cost approach to conversion; i.e., they were not making changes unless necessary to provide customer needs.

Metal producers believed increased costs could be expected in their computer and inventory operations. They also believed productivity would temporarily be adversely affected with attendant cost increases. Metal distribution centers believed the primary cost impact would be in their inventory operations.

Computer operations

Many steel companies had converted or were in the process of converting their computerized ordering and billing systems to accommodate metric units and symbols. This has not been an easy task as the following three examples show.

--One company spent 1-1/2 years to reprogram its operations. Numerous decisions on what metric codes and conversion factors to use and additional field sizes needed had to be made. Still unanswered was the question of what to do with historical data files. Systems people say they would require at least 2 years to prepare for modifying the entire computer data base.

--Another company spent 1-1/2 years on a part-time basis reprograming its order handling system.

--The third company spent 5 months modifying its system. Once completed, a major customer notified the company that future invoices would have to show both units of

measurement. Another 9 months of reprograming was necessary to accommodate this change.

Aluminum company officials told us that, although they had not converted computer systems yet, they generally expected that this effort would be costly and one that would need to be experienced by most producers to some degree. Nobody in the industry, however, knew what the total costs would be because these efforts were not accounted for as metric costs.

Inventory operations

One metal producer expected that the greatest impact of metrication would be on its inventory operations. Another says a dual inventory system would be needed which would be confusing and costly. Dual inventories in metric and customary measurement would be needed until customary units had been phased out. An official with one major metal producer noted there were 43 customary sizes and 28 preferred metric sizes of steel plates. During the transition period, inventories of all 71 sizes would probably have to be maintained. One company marketing some metric sizes had already experienced about a 10-percent increase in the number of sizes of a particular product it stocked.

According to representatives, distributors can expect significant cost increases in many areas (with no attendant benefits) because of metrication. A typical steel distributor today is likely to carry 10,000 different-sized products in its inventory. So far there has been virtually no demand on these distributors for metals meeting metric specifications, although this situation was expected to change once conversion momentum increases among metal users. Increased metric demand would mean more sizes to inventory. More space and a method of distinguishing metric from customary sizes would be required. Inventory turnover would be slower with more sizes in stock; distributors would need to invest substantial sums of additional capital to carry the additional inventory. One very large distributor estimated its costs to stock a modest range of metric sizes for just one grade of steel would be nearly $400,000.

Lower profits could result if distributors were unable to turn over their metric inventory. Timing would be very important. One very large distributor in January 1977 stocked three metric sizes of steel plate. The distributor made this investment because one of its largest customers had announced it was converting most of its products to metric dimensions and it was expected that the company's suppliers would need metric steel. Despite an all-out sales effort, none of this metric inventory had been sold as of May 1977. This

distributor told us that it had decided not to order any more metric steel unless customers make specific requests and orders were substantial to make it profitable. The distributor said it was losing money by not selling this metric inventory which must be turned over three times per year just to break even.

Productivity

Representatives of steel and aluminum firms claimed that productivity would suffer during the transition period. But, some firms believed productivity would increase after conversion was completed.

An official at one company said productivity during the transition would suffer because the total volume of products would not change, but would be spread over more sizes. Another official believed the sales order entry, production planning, quality control, and accounting departments would be the most affected next to the production and maintenance departments. One large aluminum company experienced a decrease in productivity in its forging division as the result of just a few metric orders. The decrease occurred because workers were unfamiliar with metric units. Productivity was expected to diminish further while workers were being trained.

Another company experienced a metric-related incident having an impact on productivity. Temperature gauges on furnaces were changed from Fahrenheit to Celsius. After the change an ingot was placed in a furnace to heat it to a workable temperature. The control operator set the gauge thinking it was still degrees Fahrenheit. Instead of a heated ingot, the inner furnace was covered with molten aluminum. The mistake cost about $200,000.

OTHER CONCERNS

Officials of the companies we visited believed problems during the transition period of metrication could be expected from antitrust laws and labor unions. A number of officials also expressed concern as to the role of the Federal Government in the metrication process.

Antitrust laws

Metal company officials meet through industry associations to talk metrics, but discussions remain general. Usually they do not make agreements because of antitrust fears. The Metric Conversion Act of 1975 does not contain relief from antitrust laws, and thus, industry groups believe they must be careful in their conduct.

The ANMC Metals Sector Committee favors a timetable for a smoother and less costly metric conversion between and within industries. This Committee will not, however, establish timetables for its industry as this could be construed to be an antitrust violation. According to a representative on the Committee, the industry was worried about reports of increased attention being given by the Justice Department to industry meetings on metric matters. One report specifically cited the concern of antitrust officials that meetings to set standards for metric conversion could present an opportunity for large companies to reach agreements that might result in unfair competition to small businesses. The Committee representative told us that antitrust concerns would delay conversion progress in the metals industry until they were alleviated.

The Legal Department of one steel company believed it was an antitrust violation to deprive customers of choice of product size through standardization. This view was shared by officials at another company. They believe neither industry nor individual companies can decide to limit its product lines to a few specific metric sizes and discontinue making customary sizes without facing possible suits for antitrust violation.

Labor unions

The United Steel Workers of America represents workers in 22 industrial groups, including steel, aluminum, and copper. This Union did not have a written metric policy; but it endorsed the national policy of the American Federation of Labor-Congress of Industrial Organizations, which in effect says that metric programs must reimburse workers for the cost of any metric tools, provide training at no cost to the worker, and not interfere with the seniority system. This policy also emphasized that consideration must be given to older workers who might have a more difficult time learning the new system and, consequently, may show deterioration in job performance compared to younger workers. The United Steel Workers of America would not oppose metric conversion as long as the above concerns were dealt with.

Presently, metal producers are processing the limited number of metric orders they receive by first converting them to customary units. Production departments then fill the orders without the workers knowing the orders called for metric dimensions. Plans were to continue this approach until metric orders are predominant or a metrication plan is established. Metric orders would then be processed in metric units. Many companies are now preparing plans for educating and training employees. As expected, methods of training and

approaches varied, but most companies plan to train employees as necessary and just before conversion. Few employees have received training thus far.

Officials at one company pointed out that it may be discriminatory if only certain employees receive training. Consequently, this company planned to train all employees when appropriate. Most large companies had not yet considered the issue of providing metric tools to their workers.

A Union official told us that conversion is not going to be as easy as many believe. The Union recently conducted a metric training exercise for selected production workers, and the result was utter confusion.

Government's role

Officials at several companies believe a U.S. Metric Board is necessary to assure a successful metric conversion. One official said the Board could accelerate conversion by recommending revisions to statutes that limit/or impede conversion. Also, the Board could provide leadership and direction. On the other hand, another official felt a Board would be "too little, too late." He believed any problems or concerns should be worked out within the industry by means of trade and technical associations or individual companies. Yet another official believed the Board would have little authority and no compulsory powers under the existing Metric Conversion Act.

CONCLUSIONS

The metals industry was being drawn into metric conversion by its customers--particularly by the automobile industry which is the major user of sheet and strip metal. To date, however, only a few operations have actually been affected because the metric products being asked for--mostly sheet and strip metal--can be manufactured largely with existing equipment and processes. Therefore, the metals industry has concentrated on planning for what ultimately seems to be an inevitable conversion for them, with the main emphasis directed to establishing metric standards and preferred sizes.

Metals producers and distributors see problems and higher costs stemming from conversion with few benefits for them. What the total cost to this industry would be is unknown because it is unclear what would happen during conversion. Unknowns, such as customer demand, the use of preferred metric sizes, and the duration of the conversion period, will determine the ultimate cost.

If costs and benefits to the metals industry only are considered, perhaps the industry should not convert to the metric system. However, if the industry's customers, particularly the major ones, ask for material in metric measurement, the industry producers will need to convert or they may lose business. Furthermore, if customer demands for metric products occur too slowly, a prolonged transition period with two measurement systems would result for the industry. If a drawn-out conversion were to occur, it would add to confusion and make conversion more expensive for all those associated with the metals industry.

CHAPTER 13

TIRES SIGNAL CONVERSION

IN THE RUBBER INDUSTRY

CHAPTER 13

TIRES SIGNAL CONVERSION

IN THE RUBBER INDUSTRY

Officials of the rubber industry generally believed that a conversion to the metric system is inevitable for them. Because the automobile industry--the rubber industry's biggest single customer--has begun to use metric tires on some of its new passenger cars, rubber manufacturers were beginning to produce some metric-size tires to meet this customer demand. There appeared to be no significant metric activity in the nontire segment of the industry.

Officials generally believed the industry will receive no significant benefits due to metrication. Increased standardization of tires was hoped for but seemed unlikely to occur. The industry was moving slowly and deliberately, looking for ways to implement metrication and minimize conversion costs.

Industry sources say that proper tire inflation is the most important consideration in tire safety and mileage. However, with different inflation pressure requirements for comparable metric and customary tires, and with the introduction of a new metric unit--kilopascals--for inflation pressure to replace the familiar pounds per square inch, the probability of tire over- or under-inflation is increased.

Industry and Government must coordinate their efforts to identify and minimize any potential negative impact metrication of tires could have on consumer safety if this industry converts. Persons who buy tires, as well as those who sell and service them, will need to be educated regarding the safe and proper use of metric tires and units for inflation pressure.

We focused our review in this industry on passenger car tires because they are a major part of the industry's business. We met with officials of both large and small manufacturers of rubber products; persons who sell, service, or ship these products; industry trade associations; and labor representatives. We also interviewed Government and industry representatives responsible for or concerned about tire safety. We reviewed available cost studies, company plans and policies, standards, and metric guides and manuals.

CHARACTERISTICS OF THE INDUSTRY

Sales of rubber products were about $19 billion in 1977, $10 billion of which were shipments of tires and inner tubes.

Industry products include tires and inner tubes, footwear, industrial hoses and belts, molded and extruded products, latex foam rubber products, oil seals, and various other products. The larger producers in the industry are multinational corporations.

Most products made by this industry are component parts; i.e., they are incorporated in products of other manufacturing industries. The dimensions of these products are usually controlled by the designer of the end product. Consequently, according to the Rubber Manufacturers Association--a trade association whose membership represents approximately 90 percent of U.S. rubber consumption--the rubber industry was not in a position to voluntarily change to the metric measurement system.

The rubber industry is very dependent on sales to the automotive industry. (See ch. 11 for a discussion of the automotive industry.) The Motor Vehicle Manufacturers Association in 1976 estimated that the rubber industry had about $6 billion in shipments to the automotive industry, most of which represented passenger car tires. Tires are sold to automobile manufacturers as original equipment on new vehicles and to retail outlets and merchandisers as replacement tires. Replacement tires accounted for about 70 percent of all tires produced.

CONVERSION STATUS: AUTOMOBILE TIRES

Metric tires are not entirely new to the U.S. tire market. There are a number of European metric tires which have been used mostly on imported vehicles. Since January 1968 these imported metric tires had to meet the same safety and labeling requirements as domestically produced tires.

The rubber companies have known how to produce metric tires for years because they have subsidiary plants in other countries. These companies could have produced them in this country except for the lack of demand. The automobile manufacturers determine which tires will be used on new vehicles and, consequently, they have been the ones initiating the demand for metric tires. Because most tires are used to replace those which wear out, customary tires will be needed for many years, even if a conversion is made.

When General Motors introduced the Chevette in 1975, it was the first U.S.-made automobile to use metric tires as original equipment. Metric tires were used because the Chevette was designed in metric by a GM subsidiary in West Germany. When the car's design was brought to the United States, certain changes were made to satisfy U.S.

environmental and safety requirements, but no changes were made to the tire size. GM has said that beginning with its 1978 models, any substantially redesigned car will specify a new kind of metric tire as original equipment.

Chrysler Corporation's 1978 front-wheel drive subcompacts, Omni and Horizon, were its only passenger cars for which metric tires had been developed. A company spokesperson said that Chrysler's future demand for metric tires would depend on many factors, including national metric policy and the reaction of tire producers and consumers. To our knowledge, American Motors and Ford were not using the new metric tires on 1978 models.

Tire safety standards

The National Highway Traffic Safety Administration, Department of Transportation, is responsible for developing tire safety standards. The Safety Administration had established Motor Vehicle Safety Standard 109 affecting metrication of passenger car tires which specified the allowable tire dimensions, labeling requirements, and laboratory tests for bead 1/ seating, endurance, and high-speed performance for new pneumatic tires. It also established load ratings for tires; i.e., the maximum load tires may carry at given inflation pressures.

The Safety Administration has approved over 300 different sizes of imported metric tires since 1967. These imported tires, like domestic tires, must conform to safety performance requirements expressed in customary units of measurement. For example, air inflation pressure requirements in the Standard are expressed in pounds per square inch (psi) and load rating requirements are expressed in pounds.

With the introduction of the Chevette, GM sought immediate approval of a new metric tire, according to Safety Administration officials. The agency approved the tire used on the Chevette against existing customary requirements. It did not develop metric requirements for evaluating the tires because this would have been time consuming, thereby delaying the car's introduction. It also required that the labeling on the metric tire sidewalls be only in customary units.

Anticipating further requirements from the automobile manufacturers for metric tires, the rubber industry in April

1/Bead means that part of the tire made of steel wires, wrapped or reinforced by ply cords, that is shaped to fit the rim.

1976 petitioned the Safety Administration to amend Standard 109. They wanted permission to produce a new series of metric tires known as "P" type tires ("P" meaning the tire is for a passenger car). The industry also wanted the Standard amended to permit the expression of tire load ratings in kilograms rather than pounds and inflation pressures in kilopascals (kPa) rather than pounds per square inch. (A pound equals 2.2 kilograms, and 1 psi equals 6.895 kPa.)

One major tire manufacturer said that adopting the proposed P-metric tire sizing system could be a step toward achieving a greater degree of international standardization of tire sizes, developing improved tire sizing systems, and establising industry standards governing sizes and loads for small-size tires.

The charts on the following page illustrate the size designations for a typical alpha-numeric tire and the size designations adopted for the P-metric series. The P-metric tire size designations conform to international size designations agreed to by the International Organization for Standardization.

One multinational rubber corporation questioned the wisdom of adopting the P-metric tire sizes. This corporation believed that the present alpha-numeric system for tires is well understood by the public and has proven quite workable. In a letter to the Safety Administration, the corporation stated that, in its opinion, the ISO agreements would not meet the prime objective of tire sizing standardization with the rest of the world because there was no international agreement on the subject of tire load and pressure. The corporation further stated that the substantial cost involved in converting from the present alpha-numeric tires to the proposed P-metric tires would be passed on to the American public. Finally, the corporation said that conversion would lead to a further proliferation of tire sizes in the marketplace and confuse the public.

Industry representatives said that the Safety Administration was inconsistent with the use of metric terms. For example, the proposal listed the accepted tolerance for the maximum width of metric tires in inches rather than in millimeters. Both an automobile manufacturer and officials of the Rubber Manufacturers Association, in their comments, recommended that the agency be consistent in using measurements in the Standard. They suggested that the Standard show the equivalent (rounded) customary values following metric values; e.g., "(35 psi)" following "240 kPa."

Alpha-numeric tire size designation

B R 78 -- 13

- 13 --RIM DIAMETER IN INCHES
- 78 ---APPROXIMATE HEIGHT/WIDTH RATIO (OTHER RATIOS ARE 70, 60, AND 50) REFERRED TO AS SERIES
- R ----RADIAL CONSTRUCTION (NO LETTER IS SHOWN FOR BIAS & BIAS-BELTED TIRES)
- B -----ALPHABETICAL LETTERS USED TO IDENTIFY LOAD/TIRE SIZE (THE LOWER THE LETTER, THE SMALLER THE TIRE SIZE)

P-metric tire size designation

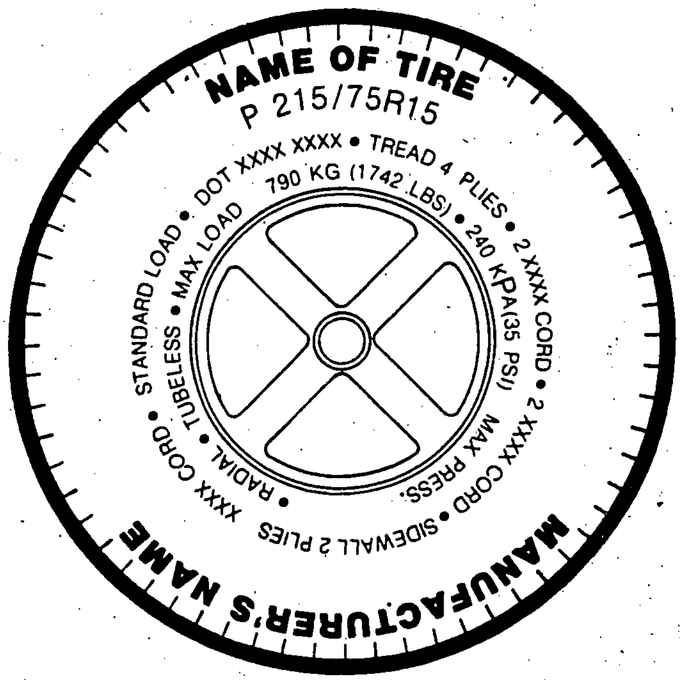
P 155 / 80 R 13

- 13 --RIM DIAMETER IN INCHES
- R --CONSTRUCTION INDICATOR
  - R - RADIAL
  - B - BIAS BELTED
  - D - DIAGONAL
- 80 ---RATIO OF THE TIRE HEIGHT TO THE WIDTH (OTHER RATIOS ARE 75, 70, 65, 60, ETC.)
- 155 ----WIDTH OF TIRE IN MILLIMETERS FROM SIDEWALL TO SIDEWALL (THIS NUMBER ALWAYS ENDS IN 5 AND IS IN 10 MILLIMETER INCREMENTS)
- P ------TIRE TYPE ("P" IDENTIFIES PASSENGER CAR TIRE)

In March 1977 the Safety Administration approved the manufacture and sale of 21 P-metric tire sizes. Some performance requirements and test specifications were also amended in metric measurement but the new metric tires were required to meet the same safety performance levels as for customary tires. The rubber industry expected to coordinate with the Safety Administration on the approval of additional sizes of P-metric tires which industry believed will be needed.

In its final ruling on the industry proposal, the Safety Administration did not adopt industry suggestions for showing metric units in its safety standards followed by the customary equivalent. The agency believed that the metric and customary units that would otherwise be shown are not exact equivalents and that showing the rounded values could only lead to confusion concerning the test conditions or performance levels required by the Standard.

However, the Safety Administration adopted a different posture pertaining to the use of both units on tire sidewall markings. In the final ruling it required that the metric inflation pressure and load rating on metric tire sidewalls be supplemented by customary equivalents rounded to the nearest whole number. The agency believed that the use of both markings on the tire sidewall (as opposed to putting them in the standard itself) would be of substantial benefit to the consumer without introducing confusion. In fact, the agency concluded that consumer confusion would probably be increased by the absence of dual labeling on metric-series tires. The following is an example of what the new markings look like on P-metric tires.



The new sidewall labeling applies only to P-metric tires. Customary and imported metric tires (other than P-metric) will continue to show only the old markings and be tested against customary requirements.

Worldwide tire standardization

The P-metric tires have been approved by ISO as the international metric standard for tires. Because the U.S. automobile manufacturers were interested in worldwide interchangeability of automotive parts, establishment of metric tire standards was a step toward that goal. But, according to the Safety Administration and rubber industry officials, complete worldwide standardization may never materialize because markets, road conditions, and regulatory requirements differ from country to country.

Several industry officials told us that differences in tire testing philosophies stand in the way of worldwide tire standardization. In Europe tires are tested for the maximum speed of the car they will be used on. Such a high-speed test for flat-out performance was not required in the United States. A Safety Administration official said that U.S.

safety tests for tires are much more stringent than those in other countries. U.S. requirements, for example, specified a high speed testing of tires but for a longer duration than other countries required, and a test to assure proper strength in the tire cords and sidewalls.

A proposed requirement by the European Economic Community that every tire size imported into the community be certified before importation could also present a problem. This requirement, if adopted, would mean that expensive and time-consuming testing would be necessary before U.S.-made tires could be exported into the European Economic Community. One Safety Administration official told us that about 100 tires of every size would have to be tested or retested.

Impact of conversion on U.S. consumers

The introduction of U.S.-made, P-metric tires on the domestic market raises two immediate questions.

--Can the U.S. driver easily and safely replace an existing tire with a metric tire?

--Will changing air pressure labeling from pounds per square inch to kilopascals pose any problem?

Replacement tires

The introduction of the P-metric tire could complicate the interchangeability and substitution of tires in the replacement market and could cause consumer confusion and increase the chances of making errors.

Tires made in the United States have been developed to a "load base" system. Under this system, any tire of the same size is rated to carry the exact same load at any given inflation pressure. This holds true regardless of the tire construction or brand. Each series in the F size--e.g., F 78-14, FR 70-14, FR 60-15, and F 78-15--is rated to carry 1,500 pounds of load at an inflation pressure of 32 psi, 1,400 pounds at 28 psi, 1,340 pounds at 26 psi, etc. As a result, a consumer could change to any tire within a series of the same size and feel assured that the new tire will support the same load as the old tire.

In contrast, the P-metric tire uses a "size based" system. Tire dimensions have been systematically developed in even metric increments (a hard conversion) with different load capacities for tires of the same size. Consequently, rubber industry officials said that there cannot be an exact

interchangeability between P-metric and customary tires as far as tire loads and inflations are concerned.

The following table compares five alpha-numeric tires in the 78 series to five replacement tires in the P-metric 75 series to illustrate the variations in tire loads and air inflation pressures between the two tire systems.

Alpha-numeric metric	Load limits at 26 psi	Load limits at 32 psi
	----------(pounds)----------	
ER78-14	1,240	1,400
P195/75R14	1,215	1,345
FR78-14	1,340	1,500
P205/75R14	1,325	1,465
GR78-14	1,440	1,620
P215/75R14	1,435	1,585
HR78-14	1,580	1,770
P225/75R14	1,555	1,720

Generally, the metric tire supports less load than the closest sized customary tire. For example, the ER78-14 tire had a load rating of 1,400 pounds at 32 psi, while its metric replacement had a rating of 1,345 pounds--a difference of 55 pounds per wheel or 220 pounds per vehicle.

In commenting on the differences in load limits to the Safety Administration, a major automobile manufacturer expressed concern that

--the use of metric tires with load limits different than existing alpha-numeric tires may result in confusion and misuse by consumers when replacing tires which could create a safety problem and

--the consumer would be better served if tires determined to be equivalent were exact in size and load carrying ability.

An official with this manufacturer said that, when replacing customary with metric tires, consumer safety would be improved only if the consumer purchased a metric tire rated to carry more load than the customary tire being replaced. However, in doing this, the consumer would be purchasing a larger and possibly a more expensive tire as a replacement for the tires

on the vehicle. An official with a leading tire producer told us that the new P-metric tires will cause difficulties and confusion for the consumer because they do not have the same load limits as the tires they are replacing. When replacing tires, adequate load capacity should be one of the consumer's primary considerations.

The Rubber Manufacturers Association told us that it has had to carefully determine which metric tires may be interchanged with or substituted for specific customary tires. In October 1977 it distributed to the industry a listing of tire sizes which may be used to replace or be replaced with the new P-metric tire sizes.

This listing showed that when replacing a P-metric tire, the Rubber Manufacturers Association encouraged using that same tire or several others. These others included P-metric and alpha-numeric tires, which usually had a greater load carrying capacity than the tire being replaced. However, when substituting a P-metric for an alpha-numeric tire, the Association sometimes recommended using a tire with lower load carrying capacity at a given inflation than the tire being replaced. In such cases, the tire consumer or dealer was forewarned that the replacement tire may require additional inflation pressure to compensate for the difference in the tire loads of the other tires on the car or tire being replaced. In its listing the Rubber Manufacturers Association warned the industry that

--the load capacity of the new metric replacement tire at the new adjusted inflation pressure must always equal or exceed the load capacity of the original equipment tire at its recommended inflation pressure and

--the maximum permissible inflation pressure shown on the new metric replacement tire sidewall must never be exceeded.

Safety Administration officials said that previous changes in tire size designations had not affected the tire inflations used. They commented that consumers will have to be informed of the differences. Generally, consumers use the same tire inflation for all tires on their vehicle, and if consumers mix P-metric tires with alpha-numeric tires on their vehicle, some problems may occur, according to these officials. However, the officials did not agree as to the severity of this problem.

Officials with the Safety Administration told us that it will take about 2 years before the P-metric tires used as

original equipment on certain 1978 passenger cars will need to be replaced at dealer outlets. The Safety Administration officials further said that tire dealers will have to familiarize their personnel with the new tires in the 2-year time frame. The dealers we contacted agreed with this assessment but did not expect this to be a problem.

According to Safety Administration officials, the industry's determination that certain P-metric tires are interchangeable with existing alpha-numeric tires may influence dealers to market only the alpha-numeric sizes currently in stock. According to an automotive safety official, the prospects that an exact replacement for the P-metric tire may not be generally available increased his concern that other size tires will be used in lieu of the size that came with the car.

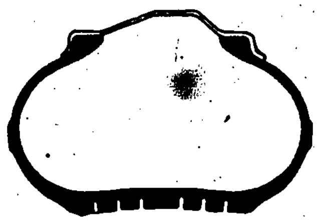
Tire inflation pressure

ISO has agreed to adopt kPa as the international metric unit for pressure. The customary measurement used in the United States has been psi. One psi is equal to 6.895 kPa. A tire inflated to 32 psi is inflated to 220.64 kPa or 220 kPa if rounded.

One of the reasons given for adopting the kPa unit in this country was to achieve uniformity with other countries. However, it is highly suspect whether uniformity will be accomplished because a number of countries, including West Germany, Italy, France, and the United Kingdom, were not using kPa, and indications were that they did not intend to do so. These countries preferred a metric unit known as the Bar. One Bar equals 100 kPa or about 15 psi.

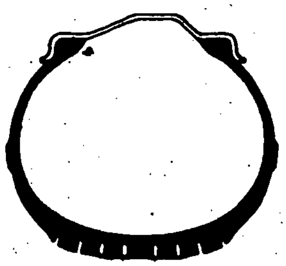
Several industry and Government officials believed that the introduction in this country of a new unit for inflation pressure could confuse the public and increase the chances of tire under- or over-inflation. According to industry sources, proper tire inflation is the most important consideration in tire safety and mileage. Correct tire inflation provides better traction and braking, better cornering, and easier steering. The following illustrates a tire in various stages of inflation.

Diagrammatic Illustrations of Tire in Various Stages of Inflation (Exaggerated Views)



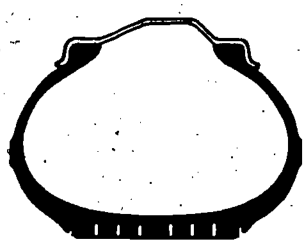
UNDERINFLATION

Causes abnormal tire deflection and builds up excessive heat, running the risk of failure. It also causes excessive wear on outer tread ribs, little or no wear in center of tread.



OVERINFLATION

Causes tires to run hard and makes them vulnerable to impact damage and weakening of the tire body. It also causes excessive wear in the center of the tread.



PROPER INFLATION

The correct profile for full contact with the road.

Underinflation will reduce load-carrying capacity of a tire and can reduce tire life. According to the Rubber Manufacturers Association, driving with underinflated tires at sustained high speeds reduces tire strength and increases the risk of sudden tire failure. Too low an air pressure results in tire flexing and heat buildup which can weaken the tire and increase susceptibility to damage or failure. Low air pressure also reduces fuel economy and may result in abnormal tire wear and adverse vehicle handling. The

following illustration shows changes that can occur when an automobile tire is underinflated.

Photo courtesy of the
Rubber Manufacturers Association

Inflating tires beyond the maximum cold inflation pressure recommended by the manufacturer for normal driving conditions can cause problems too. According to an official with the Rubber Manufacturers Association, an overinflated tire is more vulnerable to impact damage to the inner tire structure from road hazards. Overinflation also increases the likelihood of uneven tire wear and premature tire replacement as well as resulting in harsh rides. Although it is accepted practice to increase a tire's air inflation pressure as vehicle load increases, consumers are warned never to exceed the maximum permissible inflation pressure shown on the tire sidewall.

Most of the manufacturers and Safety Administration officials we visited believed that there could be some confusion in converting from psi to kPa. Several companies were concerned that law suits could be filed against them if, due to the misuse of kPa (e.g., consumer misreading, confusion), the incorrect amount of pressure was put into a tire and an accident or injury occurred. Manufacturers generally believed that proper education of car owners, service station

employees, and tire dealers would minimize potential safety hazards.

Another problem in considering a conversion from psi to kPa is whether car owners will have ready access to air pressure service calibrated in kPa. For the most part, air pressure equipment today uses psi. Gas stations provide air as a service to customers. Station owners would incur the expense of converting air towers and gauges from psi to kPa. (See also ch. 14.)

CONVERSION STATUS: OTHER PRODUCTS

Automobile companies are perhaps the largest consumers of other rubber products. However, the automobile manufacturers had not asked for other products in metric measurements. A metric official at one of the largest suppliers of other rubber products to the automotive industry told us that, although some blueprints and product labeling had been soft converted, his company has not had to hard convert a single rubber product. An official at a company which supplied products, such as rubber hoses, V-belts, and sheet rubber, to the oil, mining, agricultural, and construction industries said that none of the company's products were metric.

The fact that there seemed to be no significant metric activity in the nontire segment of the industry was substantiated by Canadian rubber industry officials who have stated that U.S. conversion of industrial rubber products was not yet in the preliminary (investigation or planning) stages of metrication.

According to one Canadian rubber industry official, the conversion of rubber products, like hose and V-belts, could be much more complex than converting tires because of the many applications and various types of these products. As an example, hoses consist of an inner line, reinforcement layers, and a cover. Many combinations of materials and construction techniques affect the properties and use of hose; hence, a wide variety of hoses is produced. Within the automotive market there are fuel hoses, cooling water hoses, air brake hoses, engine lubrication hoses, power steering hoses, and hydraulic brake hoses. Each hose has different requirements in terms of such things as pressures, temperatures, and flexing. A failure or defect in any of these hoses results in the failure of an essential auto component; therefore, a high degree of reliability is necessary.

A U.S. rubber company official told us that many U.S. standards for industrial rubber products are used in international commerce and should not be expected to change.

Consequently, this official believed that these rubber products generally should not be greatly affected by metrication as most conversion should be soft rather than hard. This is proving somewhat true in Canada where most U.S. standards for rubber products have already been soft converted by placing the metric equivalents of the customary units in brackets for Canadian use. However, when a product lended itself to a hard conversion, such as by a simple adjustment to the length of a rubber hose or belt, hard conversions were made. Certain other product dimensions are not so easily changed, like the interior diameter of a rubber hose or the cross section of a belt. These will be soft converted.

POTENTIAL COSTS AND BENEFITS

Rubber company officials generally believed that there are few benefits for them in converting to the metric system. For example, they stated conversion should not increase unit sales or increase employment. Officials were concerned about the potential costs to convert although it was too early to forecast how much of a problem the industry will have. The amount of conversion costs will hinge largely on the type of conversion made by the industry and how long the transition period will be.

The seven major companies in the industry that were included in our Fortune 500 industrial survey responded to our questionnaire (see ch. 5) in the following manner when asked about the advantages frequently attributed to metrication.

Frequently Attributed Advantages

Advantage	Agree	Disagree	Does not apply	No basis to judge
Conversion will provide an opportunity to standardize products	5	2	-	-
Trade will be facilitated through a common measurement language	5	-	1	1
The metric system is easier to use and would result in fewer errors	5	2	-	-
Conversion will provide an opportunity for improving product standards	2	4	-	1
Conversion will increase or protect the present amount of exports and work overseas	3	1	2	1
Use of the metric system will increase production efficiencies	1	3	-	3
Use of the metric system will facilitate technological advances	-	5	-	2
Conversion will stimulate your industry	1	5	-	1

The responses showed there was general agreement that the metric system is easier to use, should make trade easier, and presents an opportunity to increase standardization of rubber products. At the same time, however, metrication was not expected to increase production efficiencies, facilitate technological advances within companies, stimulate the industry, or provide an opportunity to improve product standards.

These companies responded in the following manner concerning the disadvantages frequently attributed to metrication.

Frequently Attributed Disadvantages

Disadvantage	Agree	Disagree	Does not apply	No basis to judge
Conversion will result in dual inventories	6	1	-	-
Conversion will be costly	5	2	-	-
Training employees will be time consuming	4	3	-	-
Product standards will have to be changed	6	-	-	1
Customers will be confused by the metric system	3	4	-	-
Conversion of products will require retesting	3	3	-	1

Companies were most concerned with dual inventory require- ments, changes needed in product standards, and costs. Opinions differed, however, on whether training would be time consuming, customers would be confused, or products would require retesting.

Many company officials we contacted were concerned about the potential cost of metric conversion, especially because few benefits were seen. Total cost to the industry had not been estimated, but company officials generally believed it would be significant. Industry members believe that the cost hinges on the amount of hard conversion needed and the time required to convert.

None of the companies we talked to had attempted a cost/ benefit study primarily because metric costs were hard to identify and/or quantify. Many companies believed that doing a study would be wasteful because conversion is inevitable. However, four rubber companies told us they had studied the cost impact of a metric conversion on their operations. One estimated that conversion costs would amount to about $10 million; another, between $1 million and [illegible] million; and another, about $3 million. The details of these companies' studies were not made available to us. The fourth company said its study results, which were developed in 1968, were no longer available. Companies were generally attempting to

lower costs by phasing out customary equipment through normal depreciation schedules; avoiding wholesale buying of new equipment calibrated in metric units; and training employees only as required.

Areas of cost impact

In discussing potential conversion costs, rubber company officials believed the main cost impacts would be in the areas of (1) equipment, (2) inventories, (3) productivity, training, and employee tools, and (4) computer operations.

Equipment

Tire molds are one of the major equipment items used in the industry. According to a major producer of tire building machinery and equipment, tire molds cost from $7,500 to $10,000 each depending on quantity ordered and mold size, design, and construction. Tire manufacturers have sizeable investments in these molds. Using information supplied by one large tire manufacturer, we estimated that it had tens of millions of dollars invested in molds.

A tire mold, if properly maintained, could last indefinitely. But, because of design changes in tires, a mold typically becomes obsolete in 5 to 10 years. Tire manufacturers were concerned their investment in molds may be partly lost if they had to buy new molds for metric tires and discard existing equipment before the cost of this investment was recovered. So far, manufacturers have been able to either pass on old molds to their subsidiaries or modify existing molds at a minimum of cost and use them for the tires being produced now. One company said it could make modifications to certain molds for about $50 each. However, it was too soon to know precisely to what extent existing molds will actually have to be scrapped, recut, or replaced. According to one major producer of tire molds, tire manufacturers would pay about 1 percent more--$75 to $100 each--for metric molds because the drills used to cut them must be imported.

According to officials with the Safety Administration, the larger tire makers will have an advantage over the small tire makers in converting existing tire molds for metrication purposes. Large companies were able to ship tire molds no longer needed to subsidiaries for their use in the replacement market. An official with a small rubber company told us that this practice by the large companies allows for the recovery of the cost invested in existing tire molds. He said the smaller rubber companies cannot do this; consequently, it may cost the smaller companies more per unit to produce a metric tire. He also stated smaller companies cannot purchase

tire building equipment as readily or tire molds in as large quantities, and their financial positions may not be as sound as for the larger firms. Our questionnaire survey of the seven rubber companies showed that they also believed small firms generally would be disadvantaged in converting to the metric system while large firms would tend to gain.

Many tire manufacturers also expected to incur costs for such items as metric temperature and pressure gauges, lathes, and production tools like calipers and scales. In the past couple of years, two large companies equipped new plants with some measurement-sensitive equipment calibrated in metric. One company encountered some problems with soft conversion at its plant, but a company official told us that overall there had been no significant equipment cost increase due to its limited use of metric equipment. This company considered its plant metrication efforts premature and had no plans for expanding its metric capability into other plants. The other company believed its effort resulted in useful learning experiences and the establishment of a foundation for further conversion at some later date.

Not all companies were as enthusiastic about working with metric equipment. One major company, unknowingly at the time of purchase, bought a forklift that had both metric and customary components. Once it was discovered the forklift had metric parts, the company returned it rather than purchase the metric tools and deal with any confusion that might result. The company had a policy of not purchasing any metric equipment.

Inventories

The number of different tire sizes and types has increased over the years. The consensus among Government and rubber industry representatives was that the introduction of P-metric tire sizes would add to this proliferation. The manufacture and sale of many P-metric tires has already been approved by the Government, and the manufacture of additional sizes has been proposed.

Many industry officials expected that the addition of P-metric tires would have a significant impact on inventory costs. Presently, tire manufacturers and dealers carry very small metric tire inventories. But, as requests for P-metric tires increase, tire manufacturers and distributors may need additional space in production and inventory areas. Needs, of course, will vary from company to company. Since demand for customary tires may continue for many years, metrication will result in a dual inventory system until customary tires

are phased out. Two of the largest companies in the industry believed that the transition could take 40 to 50 years.

Productivity, training, and employee tools

Every company we contacted believed productivity would decrease during the initial phase of conversion. Because tire manufacturers would initially be producing more tire sizes as metric sizes are added, officials generally believed that production line output could be affected. Production runs could be shorter which increases manufacturing costs.

The education of employees in the metric system is expected to be a big job. Several major companies believed that metric training is an area where substantial costs would be incurred. However, companies were not rushing into employee training. Industry officials said that they will begin metric training as needed.

The United Rubber, Cork, Linoleum, and Plastic Workers of America did not favor metrication if it meant workers must pay for new tools used on their jobs. Other than this, the union did not have a metric policy or plan. If employees do not pay the cost, the company must.

Most companies leaned toward supplying production workers with metric tools from company tool bins. Several companies said that the metric tools issue will be negotiated at the bargaining table. One large company believed its workers should supply and pay for their metric tools just as they do for customary ones.

Computer operations

All the major companies had their engineering and administrative data on computers. Only one company--a multinational--had completely converted its engineering data to metrics. It did so in 1971. According to one official, the rest of the industry will incur the cost of rewriting specifications and standards and operating a dual system until the computer conversions are complete. He estimated that his company will need to recalculate over 20,000 product specifications on its computer.

Most company officials told us that the conversion of their computer operations could be complicated and expensive. In our opinion the more a computer becomes an integral part of a company's operations, the more difficult and costly the conversion could be.

CONCLUSIONS

U.S. rubber company officials did not believe that metrication would result in significant benefits for their industry. Most companies were beginning to produce some metric-size tires because the automobile manufacturers have begun to use metric tires on some new passenger cars. And indications were that automobile manufacturers planned to make greater use of metric tires on future models. Thus, rubber company officials generally believed conversion of the industry is inevitable.

The transition period for the industry will depend on how quickly its customers require metric products in the future. Conversion could take a long time because automobile manufacturers will be requiring both metric and customary products for many years (see ch. 11) and other industry customers had not required metric products.

Industry officials were concerned about the potential costs of converting. Most officials believed that a conversion would increase costs because of the need to (1) replace or modify existing equipment, (2) invest more money in inventories, (3) train employees and provide them with metric tools, (4) produce more tire sizes which makes for shorter and less economical production runs, and (5) convert measurement-sensitive data bases on existing computer systems. The industry was moving slowly and deliberately, looking for ways to implement metrication at least cost.

Consumer safety may be affected. Because the load limits on the P-metric tires differed from those for alphanumeric tires, it is more likely than before that consumers may purchase a tire that has either less or greater load carrying ability than the tire being replaced. Consumers will need to make adjustments in air inflation pressures to compensate for differences in load carrying ability of these tires which means they could have tires requiring different inflation levels on a car at the same time. This, coupled with the introduction of an unfamiliar metric air inflation pressure unit--kilopascals--may increase consumer confusion and the likelihood that they may over- or under-inflate tires. Industry sources say that proper tire inflation is the most important consideration in tire safety and mileage.

The[illegible] no advantage to consumers by converting tires, as well as the information in consumer literature and on tire sidewalls, to metric. The decision by the Safety Administration to require tire manufacturers to show metric units on P-metric tires, but not on others, has resulted in inconsistent use of measurement units on tires. Furthermore,

requiring that the metric units be the predominant measure on tire sidewalls, rather than customary units, seems premature in view of the predominant use of customary units in tire air pressure devices in automobile service stations and the limited conversion activities occurring to other consumer products (see ch. 27). We believe the Safety Administration should reevaluate its requirements for the labeling of P-metric tires, giving consideration to changes being made to other consumer products.

RECOMMENDATION TO THE SECRETARY OF TRANSPORTATION

To help ensure that the measurement terms used for automobile tires are those consumers are most familiar with, we recommend that the National Highway Traffic Safety Administration be directed to reevaluate the requirement that P-metric tires show the metric units as the predominant measurements on tire sidewalls. In selecting the measurement terms to be used, the Safety Administration should consider whether it is to consumers' interests to convert tire consumer information to metric. Uniform requirements should be established for all automobile passenger car tires.

CHAPTER 14

THE PETROLEUM INDUSTRY FORESEES FEW BENEFITS

THE PETROLEUM INDUSTRY FORESEES FEW BENEFITS

Although the petroleum industry foresees few benefits, it expects that eventually it will convert to the metric system. However, there is currently little metric activity within the industry.

We believe metrication of the petroleum industry does not appear justified because:

--The petroleum industry is standardized worldwide to a large extent on our customary system of weights and measures due to the acceptability and use of U.S. technology.

--The cost of conversion may be significant, although it can be minimized through proper management of the transition period.

--No identifiable major benefits can be obtained.

Nevertheless, some petroleum companies think conversion is inevitable and have begun to plan for it. They believe:

--As some of the multinational firms in other industries convert, a rippling effect will occur.

--Metrication eventually will be mandated by the Government.

--The petroleum industry cannot hold out for the customary system while the rest of the Nation converts and the world is metric.

The petroleum industry is faced with two consumer related problems. One is the computer mechanisms in gasoline pumps will become obsolete when the price of gasoline reaches $1 per gallon. The industry needs to decide whether to redesign its pumps to handle prices of $1 or more per gallon, measure gasoline sales by the quart, or convert to metric and measure gasoline sales by the liter (a quantity slightly larger than the quart). The other problem deals with the air pressure service offered for tires at service stations.

We contacted five major oil companies; the company which produces most of the world's gasoline pump computers; and the American Petroleum Institute, the major trade association for

producers of petroleum products. We also sent a questionnaire to the Fortune 500 industrials which included 33 petroleum companies; 29 of these companies responded. (See ch. 5 for a complete analysis of all responses.) Further, we sent a followup letter to 24 petroleum companies, asking them to explain their response that metric conversion was inevitable.

INDUSTRY BACKGROUND

The United States is one of the world's largest producers and refiners of oil and the largest consumer of petroleum products. In 1976 the Nation consumed about 6.4 billion barrels of petroleum.

The petroleum industry is not only engaged in exploration and production, but also in transportion, manufacturing, and marketing. Integrated firms are engaged in all of these aspects. There are over 50 integrated U.S. oil companies. However, a far larger number of companies are engaged in one, two, or three of the industry's functions.

Petroleum marketing is a large-scale operation. The wholesale distribution of petroleum products is handled by about 15,000 companies. These companies fill bulk orders for petroleum products from service stations, commercial consumers, public utilities, transportation companies, factories, and rural farms. At the retail level there are about 13,700 fuel oil and liquid petroleum gas dealers and about 190,000 gasoline service stations. Service stations are among the Nation's leading small businesses. In 1976 the total of all service station sales was about $48 billion of which over $41 billion was for gasoline and motor oil.

Petroleum is a capital-intensive industry. For example, the Trans-Alaska pipeline, which is 48 inches in diameter and 789 miles long, cost more than $7.7 billion; a 100,000-barrel refinery can cost more than $200 million; a drilling rig may cost over $2.8 million; and an offshore installation can cost over $100 million.

More than 3,000 different products are made from petroleum. The consumer thinks of the gasoline pump as the marketplace, but the network is much more complex and goes far beyond the service station.

STATUS--VERY LITTLE METRIC ACTIVITY

Except for some discussion and planning, there has been little activity toward conversion to the metric system within the industry. The American Petroleum Institute has a membership of approximately 350 companies and 7,500 individuals.

The Institute supports an orderly conversion to the metric system and has established a metric committee. It

--endorses and supports voluntary conversion to the metric system as outlined in the Metric Conversion Act of 1975,

--plans to coordinate the petroleum industry's activities in all areas for an orderly and consistent conversion, and

--advocates standardization steps that will lead to improved efficiency or lower costs and better consumer understanding.

Regarding the latter, we were advised that this is in accordance with the Institute's overall policy toward standards.

The Institute has conducted a membership poll to determine which of the industry's 600 engineering standards for products, materials, processes, equipment, procedures, etc., should receive conversion priority. It estimated that about 150 of these could be easily converted with little or no expense; the balance will require additional study. An Institute official told us that metrication of the Institute's standards will mainly be a soft conversion. The Institute has begun soft conversion of some standards. It also has conducted a survey to determine the status and plans of the industry. The survey results will allow the development of a tentative schedule for the conversion of each phase of the industry.

Company activity

The prevailing feeling among the company officials we interviewed seems to be that, while there are few benefits, metrication is inevitable and a planned conversion is better than a haphazard one.

Each company seems to have its own approach. One company, which describes itself as supporting, encouraging, and promoting metrication, has issued no formal metric policy but expects to be predominantly metric by 1982. The company currently has two plants which use metric units for temperatures and pressures in their processing operations. However, the company must convert the data to customary units for overall reporting.

Another company formed a large metric council in anticipation of proposed national legislation providing for a predominantly metric America within 10 years. The act that finally passed in December 1975 did not contain this provision.

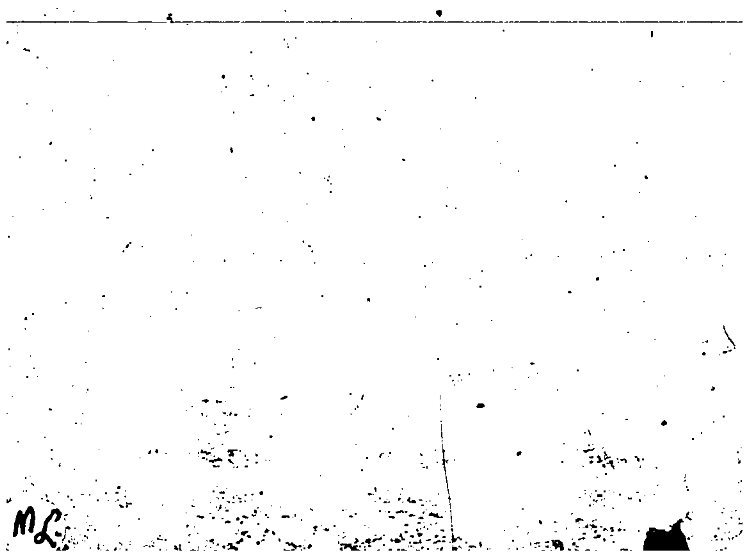
As a result, the company's metric council functions merely in an "awareness" role. The company has developed some contingency plan alternatives for conversion periods covering 5, 10, or 15 years.

We were told by another company official that although he saw no economic incentives to conversion, his company was going ahead with plans anyway. The company foresees a gradual conversion program with the pace being tied to the actions of other converting nations.

Finally, another company which states it endorses the American Petroleum Institute's policy on metrication has actually assumed a negative posture. Except for a limited awareness program for managers, it has no conversion plans. Company officials told us that if conversion does come, it will be external, and the internal operations of the company are the company's business.

When asked to describe their views on metrication, none of the companies responded that they would be leaders in the metrication process. About 46 percent indicated they would be meeting the demands of their customers; 36 percent, that they would be following the lead of others; and 4 percent, that they would prefer to block or postpone metrication.

Overall, little planning has taken place in the industry. The following table reflects the companys' responses on the current status of their metric activities.



Status of Metrication

Activities	No plans for	Plans for	In process	Completed
	-------------	(percent)	-------------	
Customer surveys	76	7	3	3
Supplier surveys	76	14	7	-
Funds budgeted for metric conversion activities	69	7	10	-
Timetable for conversion	69	14	7	-
Consumer information	66	17	7	-
Cost analysis	48	14	21	10
Employee training	45	38	14	-
Metric policy statement	41	24	7	21
Metric coordinator or committee	38	10	14	31
Coordination with industry	34	17	41	-
Coordination with government	34	31	21	-

THE INDUSTRY BELIEVES METRICATION IS INEVITABLE

If there are no economic incentives, why should the petroleum industry convert? The answer most often given by company and industry representatives was that "It's inevitable." One official said metrication was inevitable, and the only choice available was the method of implementation. Another summed it up by saying that it's not a question of "if" but rather "when" and "how." He said the two choices confronting the industry are to (1) do nothing and catch up later or (2) plan now and ease the transition.

Of the petroleum companies responding to our questionnaire, 82 percent see conversion as inevitable. Thirty-four percent see conversion as definitely inevitable, and 48 percent said it was probably inevitable. Only 10 percent believed that conversion may not be inevitable; 7 percent were undecided.

We sent a followup letter to the 24 companies which made up the 82 percent that believed conversion was inevitable, asking them to explain their response. Of these 24 companies, 16 responded to our letter. The following table shows the typical reasons we received. Some companies gave more than one reason.

Reasons why metrication is inevitable	Number of times reason was given
Worldwide competition and international trade	8
Multinationals and others causing a ripple effect	8
It is the system used worldwide	6
Government will mandate it	5
It is a superior and simplier system	2
Good for the country	2

THE PETROLEUM INDUSTRY IS STANDARDIZED-- NOT MUCH HARD CONVERSION IS ANTICIPATED

Because metrication is seen as inevitable and is not expected to generate any revenue, the strategy followed by the industry will be the one which minimizes costs and disruptions of operations. This strategy, for the most part, will dictate a soft conversion. As one company official put it, "There is nothing to be gained by the petroleum industry or its customers in making any of the hard conversions to metric." Why change the diameter of drill pipe, for instance, if every oil company in the world has standardized on one set of sizes?

The petroleum industry is standardized worldwide. Therefore, it will probably limit hard conversion to only such items as temperatures and pressures for refinery processes. Most everything else will be soft converted, such as drilling equipment and production facilities. For example, drill pipe

for the North Sea oil wells was manufactured in European steel mills to inch dimensions but soft converted to metric.

According to the Petroleum Institute, soft conversion will not be easy because of the complexity and size of the industry's standards. For example, if weather is reported in metric terms and the industry wants to go along, it will have to change 22,000 computer programs that use weather data as now reported. Also, some of the standards are 150 pages long and contain many complex tables, charts, and formulas.

The Institute expects to encounter a good bit of difficulty in soft conversion and has published a guide which provides the format for such. The publication lists the metric units first and the customary units parenthetically. One company official said that initially all work will be a soft conversion. Also, internationally some concessions will be made, but most of the International Organization for Standardization's standards will be merely soft-converted American Petroleum Institute standards.

CONVERSION WOULD BE COSTLY

The biggest disadvantage to conversion, mentioned by companies and organizations we contacted, is the cost. Specific cost data from individual companies is not readily available either because the companies themselves do not know or because they do not want to spend the time and money to develop cost estimates.

According to one company official, accurate figures are elusive because proponents give low estimates and opponents give high estimates. The Petroleum Institute contends that it is difficult to estimate the costs because much will depend on the timing and extent of conversion--the mix of hard/soft conversions, soft conversion is less costly. If conversion is handled through a normal attrition process, costs can be minimized.

The gasoline pump computer manufacturer stated that metrication will cost no matter how it is handled, but that it will cost more if the transition period is allowed to drag on indefinitely. Most companies contacted agreed on the importance of the transition period. One company official stated that the obvious task at hand is to minimize costs through optimizing the transition process.

Responses vary on the subject of tracking metrication costs. One company claims it would cost more than it was worth. Agreeing with this, another company says that

metrication costs do not warrant special accounting--the costs are unavoidable so let them fall where they may. At least one company, however, is keeping track of some of the costs as sources for a potential tax writeoff.

One company which is in the top 15 petroleum companies released an estimate for the total cost of metrication. In 1975 this company stated that the cost would be less than 1 percent of its average sales over the past 5 years (1971 to 1975) if conversion occurred under optimum conditions. We computed this to be less than $28 million. Another large American company estimates it will cost about $2.75 million to convert just its research and engineering divisions. An American Petroleum Institute Advisory Committee on Metric Planning estimated in 1971 that conversion for the industry would cost approximately $300 million. This included costs for production, transportation, manufacturing, marketing, and administration. Metrication will cost, but it would be misleading for us to estimate the costs from available information.

Responding to our questionnaire, 79 percent of the petroleum companies agreed that conversion would be costly. However, only 14 percent thought that cost was not a disadvantage, and 6 percent indicated either that cost was not a factor or they had no basis to judge the question.

Metrication would affect prices and the consumer

To what degree prices of petroleum products will increase is still unanswered. However, one company official we contacted said the consumer will ultimately bear the cost of conversion.

When asked in the long run how metric conversion would influence prices, 60 percent of our questionnaire respondents said they expect little or no change, 30 percent expect some increase, and 10 percent had no basis to judge. None of the companies indicated a decrease or a major increase in prices.

DUAL INVENTORIES COULD BE A PROBLEM

In response to our questionnaire, 66 percent of the companies indicated that dual inventories would be a problem. Only 28 percent disagreed, and the other 6 percent indicated they had either no basis to judge or the question did not apply to their firm. According to an official for the Petroleum Institute, a concerted effort must be made to coordinate and control spare parts inventories. Dual inventories may be a problem for 30 or 40 years, according to this official.

The gasoline pump computer manufacturer said it will always be possible to enter the market, but it is nearly impossible to eliminate an old system. Its old line of products will linger, and it will have an inventory problem for many years.

FOREIGN TRADE

Petroleum companies responding to our questionnaire indicated that measurement units were not ranked very high as a factor in promoting or inhibiting their exports. Competitive prices, technology, quality, and reputation were ranked well above other factors in regard to export promotion. The deterents were noncompetitive prices, tariff and nontariff barriers, competition, and shipping costs. Companies responding indicated basically no change in exports or imports arising from metrication.

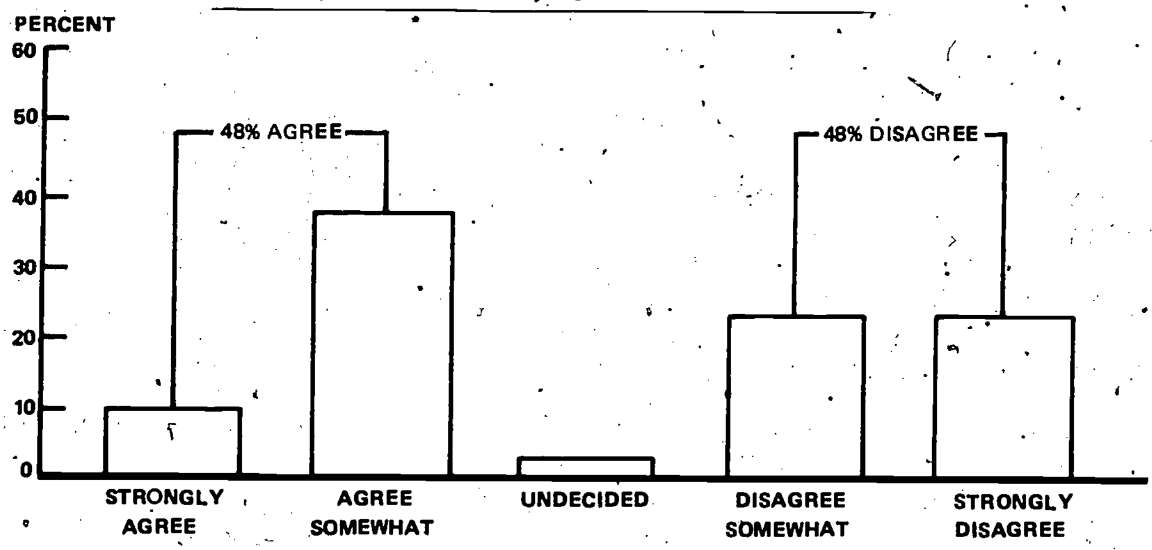
THE ROLE OF GOVERNMENT

As indicated in the table below, the petroleum companies responding to our questionnaire indicated that if metrication occurs, the Federal Government should be involved in some manner.

Federal Government role	Percent
Counsel and advise interested parties	55
Coordinate activities	45
Plan the overall conversion	28
Establish target dates	28
Other	17
Legislate the conversion process	10
Make conversion mandatory	7
None	3
Enforce the conversion process	3

Although most companies were against Federal mandates for conversion, they were evenly split on whether or not to use Federal procurement to encourage conversion as shown on the following page:

Encourage Conversion Through Federal Procurement



Legal and regulatory

Pursuant to discussions with oil company officials, legal and regulatory problems can be divided into two categories: (1) antitrust and (2) all others.

Legal problems center around the sizable assortment of Federal, State, and local laws pertaining to measurement. A common fear is that, without central coordination, individual jurisdictions may act on their own and create a chaotic situation. For example, in California sale of gasoline by the liter is now authorized. In New Jersey an oil company could not conduct its metric gasoline sales tests because a State tax law requires the motor-fuel tax to be leivied by the gallon.

The table below shows the response to the question, "Which laws or regulations currently inhibit conversion by your company to the metric system?"

Law or Regulation	Percent
State and local laws	52
Other Federal laws	31
Federal antitrust laws	21
Federal or State procurement regulations	21
Building codes	10
None	10

Overall, the State and local laws appear to be the greatest concern. This is probably because weights and measures

laws are a State responsibility. Thus, if a State requires products to be sold in only customary units, the company could not market metric-only products.

According to a Petroleum Institute official, antitrust seems to be an issue in metrication. One company official told us that the fear of antitrust was one reason there was hestitation in converting. Most concede, however, that if handled properly, antitrust will not be an issue.

Canada, when faced with this issue, modified their Combines Act (analogous to our antitrust laws) to allow companies to meet to discuss metrics. The Canadian planning committee dealing with petroleum refineries, wholesalers, and gasoline service stations was so antitrust conscious that it required Anti-Combines-enforcing-agency members to participate in its meetings.

THE TIME PERIOD FOR CONVERSION

Companies within the petroleum industry want to determine their own destinies and metricate at a pace which is most advantageous to them. They do not want a mandatory conversion. On the other hand, they want to know what their suppliers, customers, and competitors are doing.

One large company states that conversion must be voluntary and be guided by the forces of the marketplace. There should be no artificially set metric target day. Industry should be allowed to coordinate with customers, suppliers, and the public. Another firm's view is that the planning should be done at the American National Metric Council with input from the Petroleum Institute. There should be schedules but nothing mandatory. Mandates will be expensive to implement. The gasoline pump computer manufacturer, on the other hand, thinks a schedule should be determined with dates set, but the details and methods should be left up to individual companies and industries.

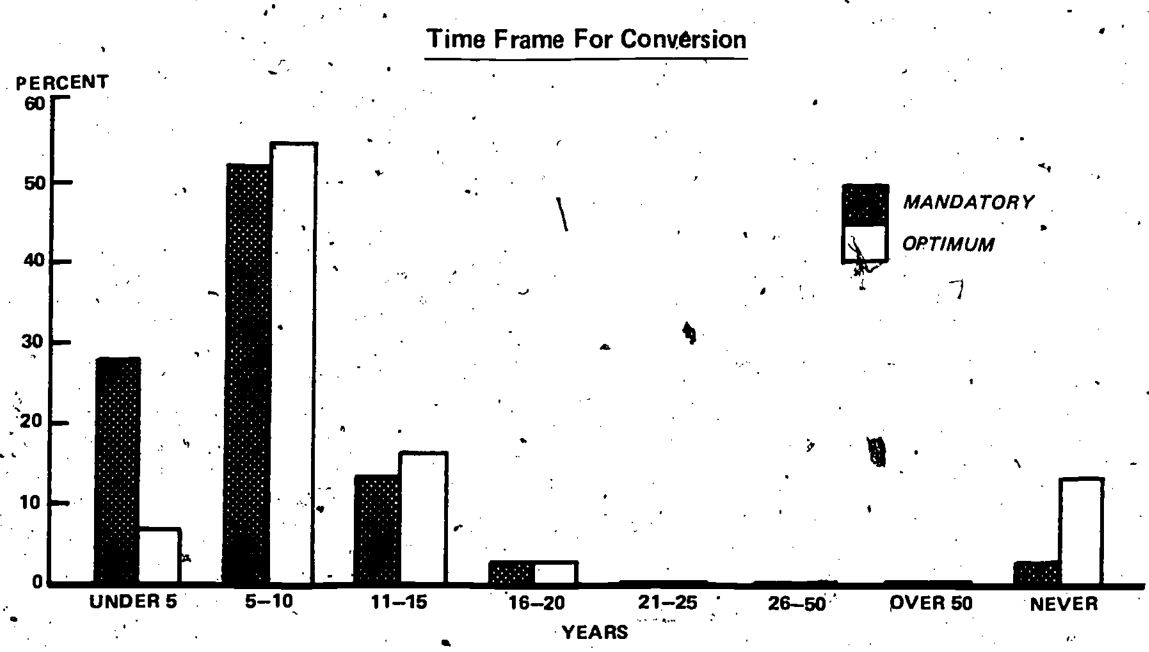
The Petroleum Institute has established a metric committee consisting of 17 members of various integrated oil companies. It does not want to see arbitrary metric target days set for the Nation but concedes that at some midpoint in the transition, some legislation may be needed.

The conversion process for the Nation must be synchronized to minimize the length of the transition period. This should be done on a line-item basis because each segment of business and society has its own unique optimization considerations. Also, there must be some effort to coordinate

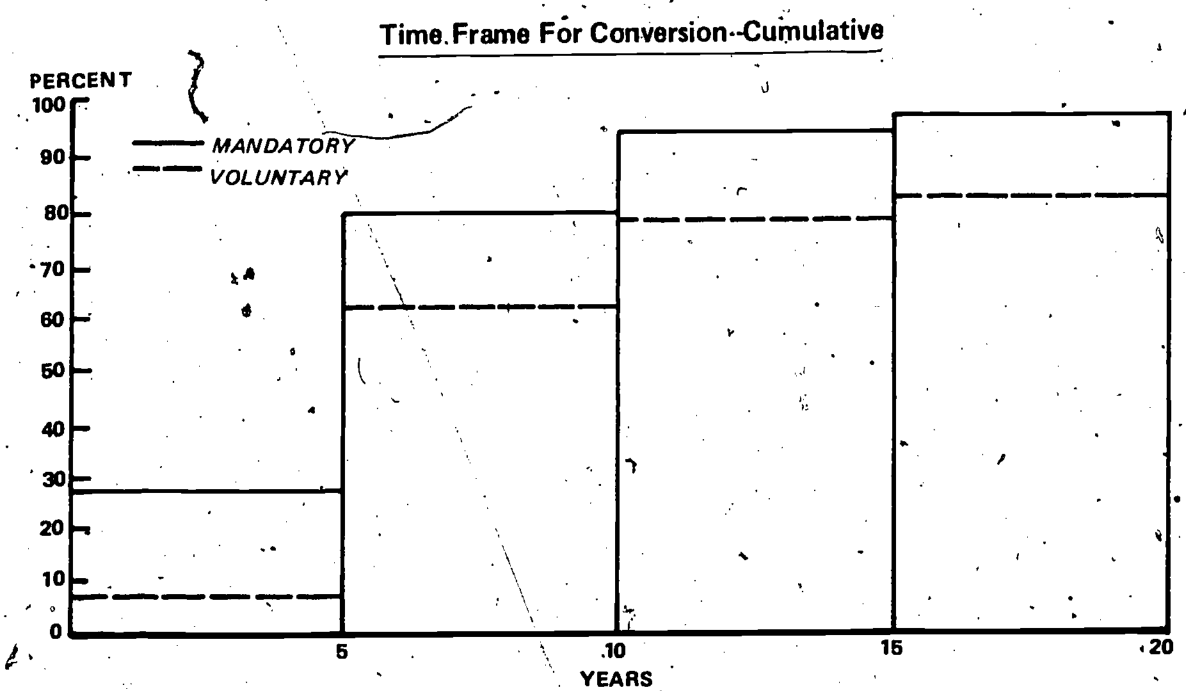
the supply of spares because we would probably be in a dual inventory system for 30 to 40 years.

One company said the United States must replace the present haphazard approach with a coordinated one. Many U.S. industries are extremely complex entities unto themselves; however, if one is talking about converting the entire economy, it is even more complex. There must be a good deal of planning and coordination. Another firm states that a voluntary approach is nice but that metrication will not happen without incentives. Presently, legislation does not provide incentives.

Petroleum companies responding to our questionnaire indicated that 5 to 10 years could be both the shortest time frame and the optimum time frame required for conversion. Several indicated that a shorter period is possible; a few others indicated either that a longer period was required or that they would never convert. The graph below shows the time frames under both a mandatory and optimum conversion.



The following graph shows the percent of conversion on a cumulative basis for a voluntary or mandatory conversion. If the conversion remains voluntary, the industry could be 82-percent metric in 20 years; however, if conversion were mandated, the industry could be 97-percent metric.



ADVANTAGES VERSUS DISADVANTAGES--FEW BENEFITS FOR THE PETROLEUM INDUSTRY

The petroleum industry generally foresees few advantages to metrication. Some companies state that there are no economic advantages, and most benefits do not relate directly to the petroleum industry. They state, for example, some basic pillars of our economy--such as the automotive industry (see ch. 11)--are converting, and this has a rippling effect on the rest of the economy.

The following table shows how the respondents to our questionnaire viewed the frequently mentioned advantages of metrication for their companies.

Frequently attributed advantages	Agree	Disagree	Does not apply	No basis to judge
	---------------	(percent)	--------------	
The metric system is easier to use and would result in fewer errors.	48	34	3	14
Conversion will increase or protect the present amount of exports and work overseas.	17	21	41	21
Conversion will provide an opportunity to standardize products.	48	24	24	3
Trade will be facilitated through a common measurement language.	62	17	10	10
Use of the metric system will increase production efficiencies	17	48	21	14
Use of the metric system will facilitate technological advances.	14	62	10	14
Conversion will provide an opportunity for improving product standards.	31	48	7	14
Conversion will stimulate your industry.	3	76	7	14

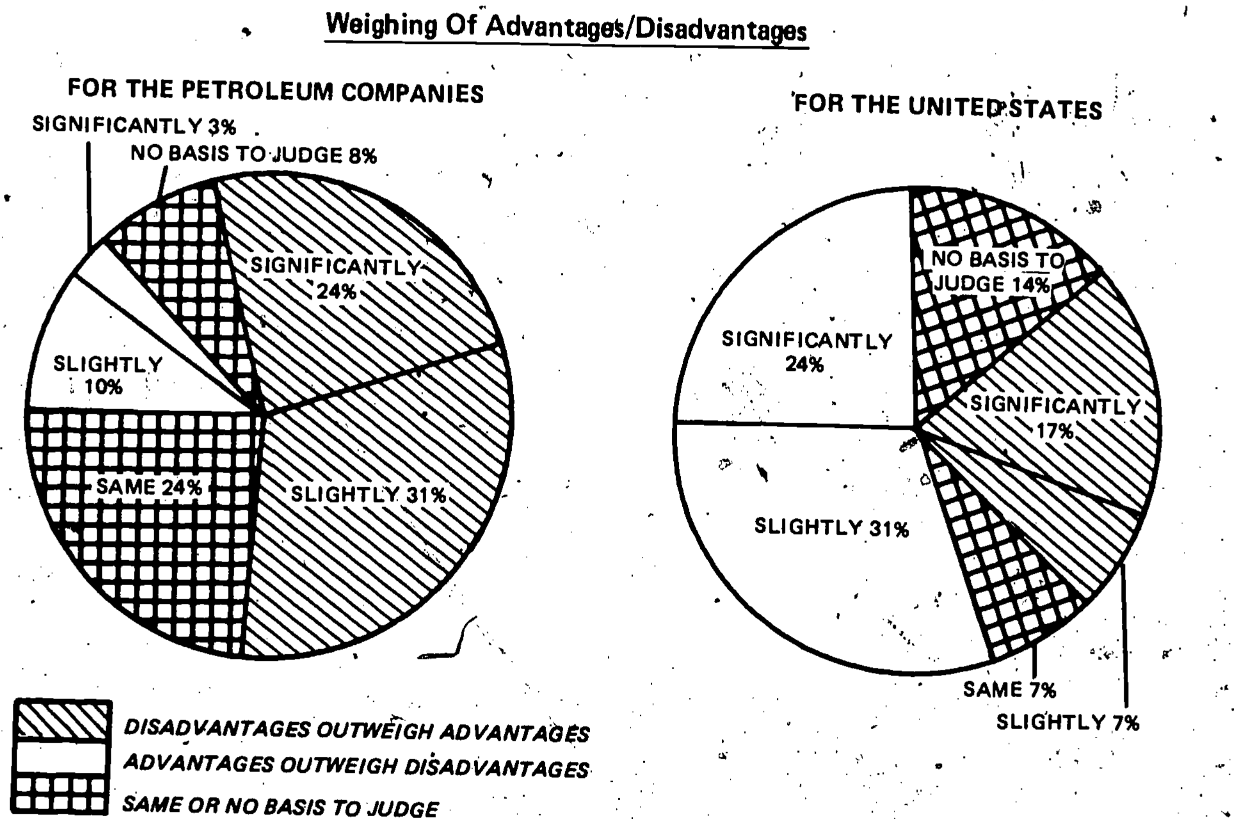
One oil company official, believing in the inevitability of metrication, states that planning and coordinating now will lead to cost avoidance later, and this is a benefit. Another major oil company says that its engineering division is doing work for all of its international affiliates; and

if they do not metricate, most of that work would be lost to European engineers. The Petroleum Institute says that engineering calculations will be made easier and, therefore, cheaper and that metrication will be most beneficial to those engaged in new technologies and construction.

The disadvantages of metrication can be summed up as costly. Employees will have to be trained; dual inventories will exist; standards will have to be changed; and tools, parts, and equipment will have to be purchased. The table below shows how the respondents to our questionnaire viewed the frequently mentioned disadvantages of metrication for their companies.

Frequently attributed disadvantages	Agree	Disagree	Does not apply	No basis to judge
	(percent)			
Conversion will be costly.	79	14	3	3
Training employees will be time consuming.	79	14	-	7
Conversion will result in dual inventories.	66	28	3	3
Customers will be confused by the metric system.	69	17	3	10
Conversion will increase the prices of your company's products.	28	34	14	24
Conversion will result in safety hazards and errors.	38	31	7	24
Sales will be lost to foreign imports.	3	72	7	17
Conversion of products will require retesting.	10	52	17	21
Product standards will have to be changed.	59	24	7	10

Evidently, the petroleum industry believes that someone other than themselves will benefit from the conversion. As shown in the chart below, 55 percent of the petroleum companies responding to our questionnaires believed that the disadvantages of metrication outweighed the advantages for their companies. Only 13 percent felt that conversion would be an advantage. However, 55 percent felt that for the Nation overall, the advantages outweighed the disadvantages, and 24 percent felt that conversion would be a disadvantage to the United States.



CONVERSION AT THE GAS STATION

The most noticeable impact of metrication in the petroleum industry for the general public will be at the gas station. The major challenge for the industry, according to the Petroleum Institute, is to make sure the public does not perceive metrication as an attempt to raise prices.

From gallons to liters

Under the metric system the liter replaces the gallon as the basic measure for liquids. A liter is slightly larger than a quart; 1 liter equals about 33.8 ounces. About 3.785 liters equal 1 gallon (128 ounces). A change to gasoline sales by the liter could be one of the few hard conversions made by the industry but one with the greatest public exposure.

How does the public purchase gasoline? Usually, the consumer fills up the tank or sets a monetary limit such as $5 or $10. Occasionally a customer orders by the gallon. One petroleum company has conducted surveys on customer reaction to buying gasoline by the liter. It sold gas by the liter in two stations in different sections of the country. Results showed about 20 percent of the customers wanted the gallon back, and the rest either did not care one way or the other or they liked the idea of the liter. Thus, it appears the effect of this particular conversion may not present a problem.

Converting the gasoline pump computer

The gasoline pump computer is the mechanism that registers the number of units dispensed, multiplies it by the established unit price, and calculates the total price. The computers for nearly all of the world's fuel dispensers are provided by a single U.S. company. The company has no metric coordinator and no metric policy, but it is interested in metrication. That interest stems from the fact that recent increases in fuel prices have made many of its computers obsolete, and future increases could render most of the remaining computers obsolete.

The problem first came to light in 1974 when the gasoline price per gallon exceeded 50 cents. It was found that about 300,000 pumps could not record a unit price beyond 49.9 cents. For those pumps limited to 49.9 cents per gallon, the unit price can be set at 1/2 the actual price, then the final total price can be multiplied by two to determine the customer's actual bill. For those pumps limited to registering sales to $9.99, $10.00 can be added to the final figure in the pump's total sales window when the price exceeds $9.99.

The following figures show the mechanical computers used in U.S. gasoline pumps and their limitations.

Gasoline Pump Computers

FIGURE 1

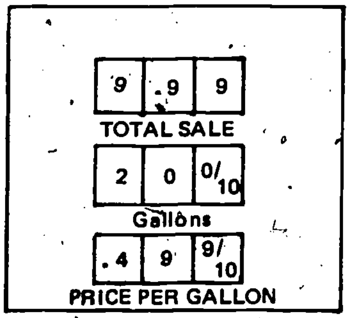


Figure 1 shows a 3-wheel--Limited Range Price Posting Computer

The limitations of use are:

--Maximum price posting of 49.9 cents per gallon.
--Maximum sales price of $9.99.

FIGURE 2

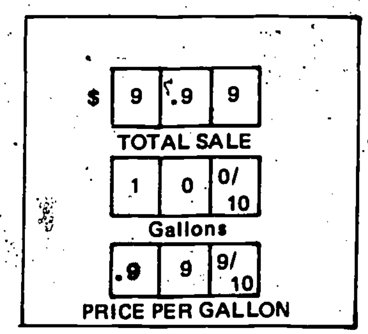


Figure 2 shows a 3-wheel--Full Range Price Posting Computer

The limitations of use are:

--Maximum price posting of 99.9 cents per gallon.
--Maximum sales price of $9.99.

FIGURE 3

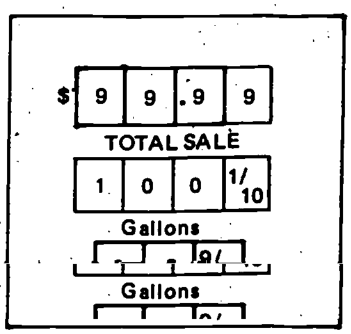


Figure 3 shows a 4-wheel--Full Range Price Posting Computer, which represents the present production design

The limitations of use are:

--Maximum price posting of 99.9

--Maximum sales price of $99.99.

The computer company has developed a gear box to allow a pump to register in gallons now and in liters later. The gear box can be installed in new computers during manufacture, and older computers can be modified either at the gas station or when the computer is sent back to the factory to be rebuilt.

The gear box costs about $25 and labor installation charges for pumps in service will add about another $25 to the cost. With about 1.3 million pumps to be converted in the United States, this means an estimated conversion cost of about $65 million. Company officials would not divulge their sales or the number of conversions already completed but said they have sold some gear boxes. They estimated that less than 5 percent of U.S. gas pumps already have dual capability with 10 to 20 percent more on order and another 20 percent being specified for future orders.

The company also sells its products in Canada. The officials estimated that about 30 percent of Canada's gas pumps have dual capability and orders have been placed for at least another 30 percent. Canada's Metric Commission has estimated that the maximum cost for converting the pumps could be as much as $200 per pump. This $200 estimate includes the $25 for the gearbox, the $25 labor charge, travel time to rural areas, taxes, and other costs. Canada is committed to be 70-percent metric at the gas pump by January 1, 1979.

Metrication could be one solution to the $1-per-gallon gasoline problem

The 1.3-million commercial pumps in operation today cannot record a unit price in excess of 99.9 cents per gallon, and the industry expects that gasoline prices could eventually exceed $1 per gallon. An oil company official advised us that modifications to a pump which would allow unit pricing in excess of $1 could cost $500 to $600 per pump.

There are several solutions to this problem. Pumps could be modified to measure gasoline sales by the quart; or the industry could convert to metric, whereby the pumps would measure sales by the liter. If gas costs $1 per gallon, the cost per liter would be about 26 cents. With the price changing to about 26 cents, hopefully it would be quite a while before the industry would again face the problem of the unit price exceeding 99.9 cents.

If the cost estimates are accurate, conversion to sales by the liter will actually save the industry $450 to $550 per pump. The industry would be spending about $50 per pump for metrication, but saving the $500 to $600 required to modify the unit-pricing mechanism. With 1.3 million pumps, this

could result in savings of about $585 to $715 million. A change in the unit of measure is the key; metrication is just one of the solutions because the same effect could be achieved by changing from the gallon to the quart.

In 1974 the gasoline pump computer producer presented a paper to the National Conference on Weights and Measures, suggesting that the measured unit be changed from gallons to quarts. This would allow the price to go up to $3.99 per gallon (99.9 cents per quart) before the limits of the computer were exceeded. Later, if the United States converted to metric the unit could be changed from quart to liter. The National Conference was opposed to quart pricing.

Since the public usually does not purchase gasoline by volume but rather by dollar amount or tank full, we believe that the National Conference on Weights and Measures should reconsider their opposition to using quarts rather than gallons if gas pumps are not converted to metric.

Timing the conversion would be important

Officials at the computer company pointed out that a crash conversion program for gas pumps would not be good. The company was forced into a crash program for the no-lead gasoline program in 1969. The abnormally high demand for parts, 150- to 200-percent above normal, was met, but there were not enough qualified technicians available to install the equipment. The equipment was still in warehouses 2 or 3 years later. The same thing could happen if metrication turns into a crash program. The officials estimate that a a goal of 80-percent metric in 5 to 7 years is reasonable.

Tire pressures

Providing air for tires at service stations is a problem today. According to an official of the Petroleum Institute, service station operators are tired of offering this free service. The Tire Industry Safety Council, a private organization representing the tire industry, is concerned that more and more gasoline service stations are discontinuing the air service. Proper inflation is an important factor in tire safety and mileage. (See ch. 13 for a discussion on metric tires.) Service stations are not required to have the air service and, even if they have it, there are no minimum maintenance or reliability requirements.

In 1972 the National Business Council for Consumer Affairs, a Federal Government advisory committee, recommended that the Federal Government initiate and coordinate a continuing program to assure accurate readings on fixed

air-pressure-measurement devices used by the general public. The intent of the recommendations was to have State weight and measure laws require accurate devices. The petroleum companies endorsed the recommendation; however, nothing has been done according to the Tire Industry Safety Council.

According to the Department of Transportation's National Highway Traffic Safety Administration, only two companies are known to have the capability to build service station air pumps which are calibrated in kilopascals rather than pounds per square inch.

Questions about whether the service will continue to be offered and how best to assure the accuracy of these devices must be answered, as well as the questions of whether or when to go metric. To our knowledge, no government regulatory body has jurisdiction.

Recently, a coin-operated machine for air has been introduced which may solve the air service problem. The machine provides for 4 minutes of service for a quarter. However, this machine is not equipped with an air-pressure measurement device, therefore, the user would have to provide his own air gauge. It is too early to determine whether this new machine will assist customers in obtaining proper tire inflation.

Other products

In addition to gasoline, other products generally provided by the petroleum industry will have to be packaged and described in metric units for a complete conversion.

The only studies in this area we know of concern the conversion of the oil can. Through the auspices of the Packaging Institute, a study for converting the 1-quart oil can to a 1-liter can has been completed. Essentially, the existing equipment can be modified to allow production of liter cans of oil. The diameter of the can will remain the same, but the height would be increased slightly because a liter is about 6-percent larger in volume than a quart.

However, several other matters, such as new cartons and storage and display areas, must be analyzed to determine the full impact of the taller can. Additionally, one company said that they need information from the automobile industry as to the impact of putting 4 liters (135.3 ounces) into a car which currently requires 4 quarts (128 ounces) of oil. The companies also need to know when the automobile industry is going to specify the liter for crankcase requirements. Coordination with the automotive sector will be a continuing requirement throughout the petroleum industry's metrication program.

CONCLUSIONS

The petroleum industry firmly believes in the inevitability of metrication but foresees no major economic advantages to converting. Planning for the conversion has begun in some areas. The industry prefers a well-planned and coordinated conversion arrived at voluntarily, instead of the current situation where no firm national commitment or board is planning the conversion.

The industry believes metrication is inevitable because:

--Actions by multinationals and others have provided a rippling effect.

--Metrication eventually will be mandated by Government.

--The petroleum industry cannot hold out for a customary measurement system while the rest of the Nation converts and the world is metric.

Not much hard conversion is anticipated because the industry has achieved a very high level of international standardization. Most plant and equipment items will be soft converted; hard conversion will be limited mainly to readouts for temperature, pressure, and volume, such as retail sales for oil and gasoline.

Cost of conversion is difficult to estimate but appears to be significant. However, it can be minimized through proper management of the transition period.

Gasoline prices at the retail level may exceed $1 per gallon in the future. When they do, the industry will then be faced with the alternatives of quart or liter sales to solve expensive equipment modification problems. The adaption-of-equipment problem is present whether the metric system is adopted or not. However, if the United States adopts the metric system predominately, State laws will have to be changed to allow gasoline sales by the liter as this is currently prohibited in some States.

Traditionally, tire air service has been provided by the gasoline station. However, air service and tire pressure equipment are neither required nor maintained for reliability. The industry has supported recommendations in this area, but no actions have been taken. Even without conversion, the Departments of Commerce and Transportation; the petroleum, tire, and automotive industries; and the States should work on a program to ensure that air pressure services continue to be

available to the general public because proper inflation is the most important factor in tire safety and mileage. The public needs to be assured of the accuracy of devices used to measure tire air pressure whether the units used are customary or metric.

RECOMMENDATIONS

Recommendation to the Chairman, U.S. Metric Board

Gasoline pump computers may have to be changed because of the increasing unit price per gallon. Therefore, we recommend that the U.S. Metric Board advise the petroleum industry of the conversion plans, if any, of other related consumer products. The petroleum industry then can plan for the volume unit price change to the quart or liter, depending on what measuring system other consumer products will be sold by.

Recommendation to the Secretaries of Commerce and Transportation

We recommend that the Secretaries of Commerce and Transportation report to the Congress what actions need to be taken to provide adequate available air service to insure tire safety and longevity to the general public, particularly since the tire industry began introducing metric tires.

CHAPTER 15

FLYING WITH THE METRIC SYSTEM

CHAPTER 15

FLYING WITH THE METRIC SYSTEM

PHOTO COURTESY OF THE BOEING AEROSPACE COMPANY.

BOEING 747

The United States is the world leader in aerospace technology and production. About 70 percent of the civilian commercial jet aircraft, excluding the Soviet national airline, and over 90 percent of the world's general aviation fleet are of U.S. manufacture. In addition, the United States is a world leader in commercial aviation. Excluding the Soviet Union, U.S. airlines carry about 47 percent of the world's passengers and about 42 percent of all goods shipped by air.

The U.S. aviation community--airlines, pilots, aircraft owners, and Government--is concerned about safety in air operations during metrication. The United States uses the customary system for flying. Internationally, however, both systems are used, and each country specifies the terms to be used in that country. Some customary units are used more than the metric units in several instances. The use of one measurement system for air operations worldwide has been sought for over 30 years but never attained.

The aerospace industry--manufacturers of aircraft, space vehicles, missiles, and a wide assortment of instruments, parts, and related equipment--believes that metrication is inevitable for itself and the Nation. A number of factors have contributed to this conclusion: the 1971 National Bureau of Standards metric report, which stated there was no question that the United States should convert; the automotive industry and other multinational companies' conversions, which are having a rippling effect throughout the economy; a 1975 aerospace industry report on metrication; and the Metric Conversion Act of 1975. Taken collectively, the industry believes these factors indicate a trend that it cannot ignore.

Generally, neither the aviation community nor the aerospace industry could identify any major benefit from metrication which would offset the cost of conversion. Both groups expect the Federal Government to play an important role in planning and coordinating metrication. The aviation community points out that the Federal Government has the statutory responsibility for air safety and therefore must assume the leadership in this area.

The aerospace industry has not received much demand for metric products and anticipates that Government orders for new products may lead the way to metrication. Efforts thus far have been concentrated on metricating engineering standards that are essential to the industry, even though U.S. aerospace engineering standards, which are based on the customary system, are used throughout the world to build aerospace products.

We contacted trade associations representing the aerospace manufacturers and U.S. airlines. We discussed metrication with selected manufacturers and airlines and Federal agencies. We reviewed available reports and pertinent documents. We also sent a questionnaire to the Fortune 500 industrials, which included 14 aerospace companies, and all responded. (See ch. 5 for a complete analysis of all responses.)

AVIATION COMMUNITY AND THE AEROSPACE INDUSTRY

The term "aviation community" refers to those persons and organizations involved in flying, directing, and controlling aircraft in flight. This includes, but is not limited to, pilots, airlines, aircraft owners, air traffic controllers, and the Federal Aviation Administration (FAA).

The aviation community is highly regulated, with FAA responsible for U.S. air safety. The civil aviation fleet in the United States contains about 184,000 aircraft and is

divided into two major groups. General Aviation is the largest group--about 182,000 aircraft--and covers those aircraft used by individuals, companies, and corporations. The scheduled airlines are the second group. In 1976 U.S. scheduled airlines had about 2,300 aircraft in their fleet and transported about 223 million passengers. They collected about $17.5 billion for their services.

In 1976 there were about 14,000 airports in the United States according to FAA reports. About 400 of these had control towers operated by the FAA. At these 400 airports, there were about 64 million takeoffs and landings with general aviation accounting for about 76 percent; airlines, 20 percent; and the military, 4 percent.

The term "aerospace industry" describes the manufacturers of products, such as aircraft; space vehicles; missiles; and a wide assortment of instruments, parts, and related equipment. The aerospace industry is diverse and complex. Although dominated by a few giants, the industry has a very broad base with more than 3,500 suppliers. Characteristics of the industry are its high degree of technology; its integration with other high technology fields, such as electronics and computers; and the long lifespan of its products.

The United States dominates nearly all aspects of the world's aerospace industry. The industry had about $29 billion in equipment sales in 1976. Government sales--for both domestic and export use--accounted for about 67 percent of all aerospace business. Nearly a third of the industry's total sales of aerospace products were to foreign markets, either directly or through foreign assistance programs. Aerospace export sales were exceeded only by agricultural exports as a positive contributor to the U.S. trade balance.

SHOULD AIR OPERATIONS CONVERT?

Measurement is an integral part of flying, directing, and controlling an aircraft. For safety and efficiency in air operations, measurement units and terms have been standardized nationally and to some extent internationally. Standardization, it is generally believed, will reduce confusion or misunderstanding and may aid in preventing accidents. Complete international standardization on measurement units, based upon the metric system, is being sought. But, because of the relative standardization already achieved, concern has been expressed on the advisability of metricating U.S. air operations. These concerns cover safety in air operations during metrication and the relatively high cost of converting equipment.

Air operations today

Air operations is an all-encompassing term used to describe just about anything or anybody exerting a control over an aircraft's flight. It includes radio procedures, emergency procedures, enroute and terminal navigation aids, maps, charts, radar and instrument approach procedures, communications between the pilot and ground personnel (such as the tower operator or the air traffic controller), and many more related items.

To make aviation as safe as possible, the communications and procedures used in air operations are regulated and standardized for each country and internationally as much as possible. FAA has the responsibility in the United States for regulating air operations and developing and operating a common system of air traffic control and air navigation. In addition, FAA issues and enforces regulations on operating and maintaining aircraft; certifies pilots, aircraft, and airports; and operates air navigation and communication facilities.

International air operations is the concern of the International Civil Aviation Organization (ICAO). This treaty organization, of which the United States is a member, seeks agreements with its members on rules, regulations, and procedures to make international aviation as safe as possible. It is a specialized agency of the United Nations and is financed by contributions of its member States. ICAO has no compulsory powers.

ICAO has sought to standardize international aviation on metric units since its inception in 1944. Many members, including the United States, have resisted this effort and continue to use customary units for air operations. In 1976 ICAO's Air Navigation Commission prepared a comprehensive paper on standardization of measurement units for international aviation. The paper stated that the paramount need in the air operation area is standardization. The Commission concluded that the commitment to standardization may take precedence over converting to the International System of Units metric system. The Commission stated that ICAO's overall objective is the singular use of a standard measurement unit based on SI units, except in those cases where the use of a specific SI unit is impractical or undesirable.

Presently, both customary and metric measurement units may be used for air operations. Nations may use either the ICAO Table or ICAO's Blue Table, or they may choose the table which comes closest to their needs and file exceptions for specific deviations. The United States uses the Blue Table

with a number of exceptions. According to ICAO reports, 47 countries use the ICAO Table, but 13 have filed exceptions. There are 64 countries following the Blue Table, and 12 (including the United States) have filed exceptions. No country uses the SI metric units exclusively. The following table contrasts the ICAO tables, the SI metric units, and the units used by the United States.

Measurement Units for Air Operations

Measurement	SI metric	Tables: ICAO	Tables: Blue	U.S. system
Distance:				
long	kilometer (km)	nautical mile (nm)	nm	nm
short	meter (m)	m	m	ft
altitude/ elevation	m	m	ft	ft
Speed:				
horizontal	meter per second (m/s)	knots (kts)	kts	kts
vertical	m/s	m/s	ft/min	ft/min
Visability:				
long distance	km or m	km or m	km or m	statute mile
short distance	km or m	km or m	km or m	ft
Altimeter setting (atmospheric pressure)	Pascal or kilopascal	millibar	millibar	inches of mercury
Temperature	kelvin or Celsius	Celsius	Celsius	Fahrenheit
Weight	kilogram (kg)	metric ton or kg	metric ton or kg	pound
Time	second	day/hr/min	day/hr/min	day/hr/min

Neither the ICAO Table nor the Blue Table lists kilometers for distance measurement (both show nautical miles), meters per second to measure horizontal air speed (both show knots), Pascals for altimeter settings (both show millibars), Kelvin for temperature (Celsius is shown), nor the second as the unit for time (both show the date/time group, that is 071350 means the 7th day of the month at 1:50 p.m.).

The only differences between the ICAO Table and the Blue Table are that the Blue Table lists feet to measure altitude and feet per minute to measure vertical speed.

Germany, Italy, Mexico, and the United Kingdom reportedly adhere to the Blue Table. Canada and Japan follow the Blue Table with some exceptions. France and Brazil reportedly follow the ICAO Table, and the Soviet Union follows the ICAO Table with exceptions. However, officials of various aviation community organizations informed us that most countries use feet rather than meters for altitude. They told us that the Soviet Union and East European countries are the only countries which use meters for altitude.

We found that although several countries told ICAO they adhere to the ICAO Table without exception, these countries use feet for altitude rather than meters. According to an ICAO official, member countries are required to notify ICAO of all differences, but not all members do so. He did not know of any accidents caused because countries used feet rather than meters, but said the potential existed.

The measurement units used for air operations in Canada and the United States are essentially the same, but there are some minor differences. For example, Canada uses either statute miles per hour or knots for airspeed, and the United States uses only knots.

<u>Continued international planning for metrication of air operations</u>

ICAO's Air Navigation Commission has approved a proposed long-range plan for metricating most aspects of international air operations. A 1977 report, requested by the Commission, concluded that ICAO's current rules on standardization of measurement units were not broad enough in scope to promote the objectives of a single standard measurement system for air operations, based on the SI metric system. It was noted that the aviation industry had been slow to implement the SI system, primarily because of the lack of adequate financial incentives and knowledge concerning the effects on safety.

The report further concluded that ICAO should take the lead by implementing three basic sequential phases of long-range planning to achieve its objectives:

--An initial phase which would consist of revising its rules on measurement units encompassing the use of SI units, with specific exceptions which reflect present realities.

--An intermediate phase which would follow and consist of developing implementation plans for the exclusive use of SI units and those units outside the system which have been retained for general use, such as liter and hour, and those retained for temporary use, such as knot, nautical mile, foot, and bar. (This phase could require 10 to 15 years to complete.)

--A final phase which would consist of developing implementation plans for the exclusive use of SI units and only those units which have been retained for general use in aviation. The temporary units of knot, nautical mile, foot, and bar would be eliminated during this phase. (This phase could require an additional 10 years to complete.)

The intermediate and final phases of planning must consider the financial incentives and human factors (safety).

The Commission agreed with the conclusions of the 1977 report and the multiphase process of implementation. It requested the development of proposals for amending ICAO's rules on measurement units and, within 1 year, a report on the implementation of the later phases.

In September 1977 the Commission requested comments from ICAO members and interested parties on the adoption of SI metric units for international air operations and proposals for a timetable to phase out customary units. As of February 1978, not all comments had been received, according to an ICAO official.

Indications are that a number of ICAO members and some interested parties oppose complete adoption of the SI system. The U.S. representative to ICAO responded, in part,

"* * * more than 80% of the world's aircraft are equipped for operation by reference to the units 'foot', 'nautical mile', and 'knot.' Additionally, in view of the expense of modifying these aircraft to operate by reference to SI units, the limited benefits gained, and the hazards which may be involved during transition, the United States withholds commitment to any time frame for termination of these [customary] units * * *."

An official of the International Air Transport Association, which represents international airlines, told us that while the Association had not officially commented on the ICAO proposal, it had received more replies from its members than normal. Its members were firmly opposed to the changes,

particularly the changes of feet to meters and knots to kilometers per hour. The official characterized the opposition as "notably vociferous" on the economic impact of converting equipment.

U.S. concerns on conversion

Safety and the lack of incentives for conversion are the principal factors mentioned in discussing metrication of U.S. air operations. At a 1976 FAA-sponsored, industrywide consultive planning conference, representatives of the aviation community pointed out that these concerns must be addressed before conversion could occur. The aviation community is looking to the FAA to take the lead in any movement to metricate air operations.

The safety concerns center around the communications between pilots and ground personnel and the ability of these people to accurately transmit and respond to different measurement units. The problem is referred to as human factors. The question is whether during a transition period--from customary to metric units--the pilot and ground personnel can communicate without confusion or misunderstanding. It is feared that communication problems could occur and safety could be jeopardized.

The aviation community preceives that there is no incentive to convert because U.S. air operations are standardized--everyone is using the same units--and converting equipment will be expensive.

Attitudes on safety and conversion

Representatives of the aviation community at the November 1976 consultative planning conference expressed the following views:

--Air Transport Association (represents U.S. airlines): During a transition period, "the name of the game here is safety." Careful consideration must be given to the how and when of the transition.

--Aircraft Owners and Pilots Association (represents individual aircraft owners and pilots). The Association's policy on metrication is to see that the conversion is not costly in terms of money or lives. The conversion must be very well planned and coordinated.

--Professional Air Traffic Controllers Organization (represents air traffic controller personnel): Converting will be an immense task. Much of the conversion will

have to occur in a short period because it will be impossible to have parts of the country operating on different systems.

American National Metric Council's Aerospace Sector Committee, which provides a forum for metric planning, has an air operations subcommittee. The May 1977 forward to the Sector Committee's metrication plan states:

"* * * metric conversion in the world's airways and cockpits must be thoroughly assessed and coordinated. Unilateral action by any element of the airways system could result in catastrophe. Only after identifying and addressing all the potential problem areas can the decision be made as to whether it is even feasible to consiver converting to metrics * * *."

FAA reports that air safety is paramount in its thinking on metrication.

Little action to date

Notwithstanding the safety concerns, very little action has taken place. At the November 1976 consultative planning conference, it was concluded that there was no reason to act because no specific government policy states that the United States will be predominantely metric within a given time frame. Also, FAA is looking to the aviation community for some signs that it wants to convert. No signs have been given; consequently, no progress is being made.

Some members of the air operations subsector of ANMC's Aerospace Sector Committee believe that its planning activities are premature and that its activities fall within FAA's responsibilities. FAA, in turn, acknowledges that by law it has the basic responsibility for the national airspace and flight operations but believes the ANMC group can provide comments, ideas, and recommendations.

One proposal made at the 1976 consultive planning conference was that FAA should determine the units to be used before attempting to decide how to implement the change. In February 1977 a Federal interagency group on international aviation agreed to study the units in question. The study was expected to take 1 year. The results of this study were to be used as the basis of the U.S. position to ICAO regarding the units to be used. However, in December 1977 we were informed that a study on units would not be done. In February 1978 an FAA official said FAA had informed ICAO that, while the United States has the legal basis to act, the

U.S. Metric Board has not been formed and it would be premature to establish a U.S. position.

Cost of converting

Complete estimates on the cost of converting equipment and instruments used for air operations are not available. The Air Transport Association anticipates that the costs will be significant but has not estimated the cost. ICAO and FAA have made some preliminary estimates.

ICAO estimated in 1976 that about 90 percent of the world's civilian aviation fleet--25,000 commercial air transports and 220,000 private aircraft--were equipped with non-SI metric measuring instruments. They estimated the cost of changing four instruments--airspeed indicator, vertical velocity indicator, and two types of altimeters--in the world's civilian aircraft fleet would be $1 billion. The FAA has estimated that replacing three of these instruments in the U.S. fleet will cost between $400 and $500 million. The U.S. fleet consists of about 2,300 commercial aircraft and 182,000 private aircraft. The estimate does not cover military aircraft.

Additionally, in 1976 FAA reported estimates for converting some of its activities. These included $2.3 million for converting a test center, $900,000 to develop modification kits for some ground equipment, and $1.5 million to develop a conversion program for software.

FAA has not determined the total cost of conversion, but it expects to conduct additional cost studies. It is expected that equipment conversions and the testing required to validate the conversions will demand many staff years of effort and the cost will be extensive, according to an official.

Besides converting equipment, the aviation community will have to look into converting the vast array of charts, maps, instruction and procedure manuals, regulations, other publications, and weather information. FAA reported in 1976 that its Air Traffic Service had concluded that a 12-month lead time will be required to convert handbooks and Federal Aviation Regulations and Advisory Circulars.

A February 1977 report of the FAA metrication group indicates little additional conversion activity on FAA's publications. It was reported that metric units are provided in a number of publications but little intent to convert publications which did not already contain this information.

On weather information FAA is aware of the National Weather Service's proposed plan for conversion. (See ch. 28.) It participates in an interagency committee on weather information exchange, which as of November 1977 had determined not to change reporting aviation weather information. However, if the National Weather Service implements its plan, aviation weather information will still be reported in customary units until such time as aviation converts.

BUILDING METRIC AEROSPACE PRODUCTS

Aerospace manufacturers view metrication as inevitable, but customer demand for a metric product is practically nonexistent at this time. The principal problem facing the industry is the conversion of its engineering and product standards. The industry must rely on thousands of these standards in producing its products.

Aircraft manufacturing can be divided into two groups which overlap each other. The first is called general aviation aircraft, which is a term generally referring to the size or use of the aircraft. General aviation aircraft are generally small aircraft rather than the larger commercial types. It includes such aircraft as the bi-wing, used for crop dusting; small business or pleasure aircraft, used by individuals or companies; and small jets, used by corporations. General aviation manufacturers usually produce for the civilian market, but the military also buys some of their products.

The second group covers essentially all other aerospace products. The product range is large, covering everything from commercial jets used by airlines and the military to jet fighters, missiles, and space vehicles bought by the Government.

Many believe metrication is inevitable but few want to lead the conversion

Metrication in the aerospace industry can be described as varied and contradictory. This situation comes about through the existence of two counteracting situations:

--The "inevitability syndrome," the acceptance as fact that metrication is inevitable.

--The "chicken/egg syndrome," which translates to, "I'm ready to accept a metric product whenever you produce it--economically" and the opposite view, "I'm willing to build you a metric product if you're ready to order it--and pay a little extra for it."

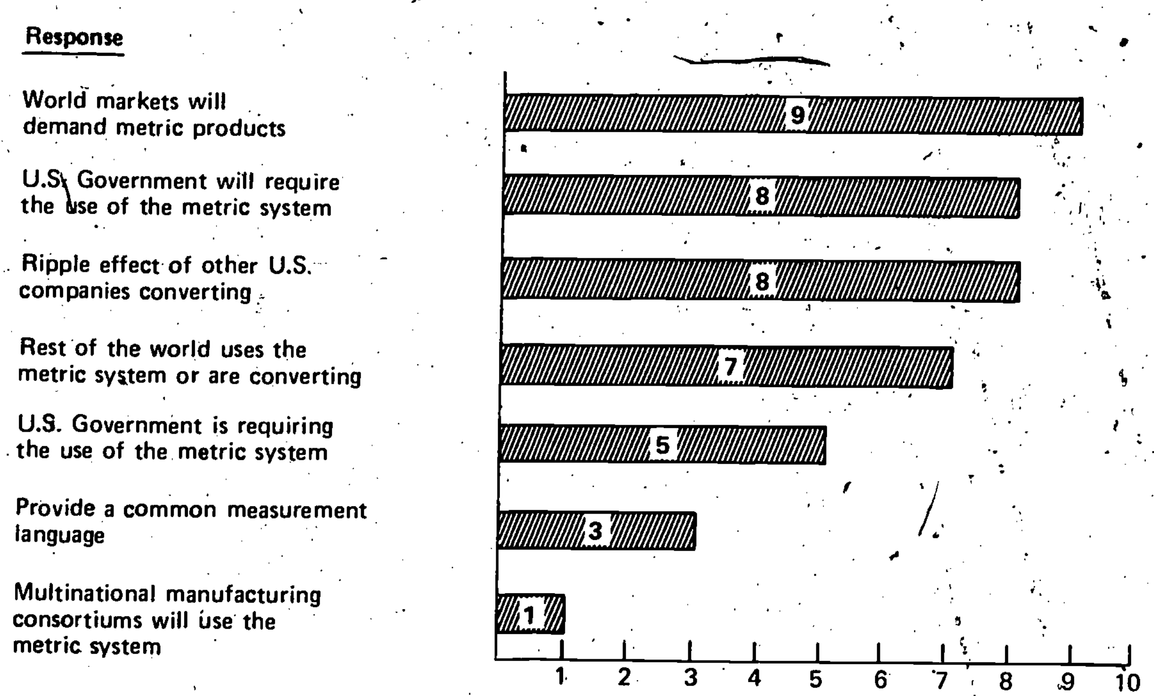
So, although most are convinced that metrication is coming, few (producers or customers) want to take the initiative for metric production.

Inevitability

The fact that aerospace manufacturers view metrication as inevitable has surfaced during our interviews with selected companies and their trade associations. It is also evident in a 1975 industry metrication report and 13 of the 14 responses by aerospace companies to our Fortune 500 questionnaire.

We sent followup letters to the aerospace companies that said metrication was inevitable; of these, 11 responded. We asked why metrication was inevitable. The answers were generally that world markets may dictate that U.S. products be metrically dimensioned. Also, company officials responded that they anticipate that the Government--primarily the Department of Defense and the National Aeronautical and Space Administration--will require metric products. Finally, they said that as U.S. multinationals convert, such as in the automotive, computer, and farm industries, there will be a rippling effect. This means that as common suppliers convert, metric products will be available at less cost than customary products. Their reponses are summarized in the chart below.

Perceptions on Why Metrication is Inevitable



Chicken/egg syndrome

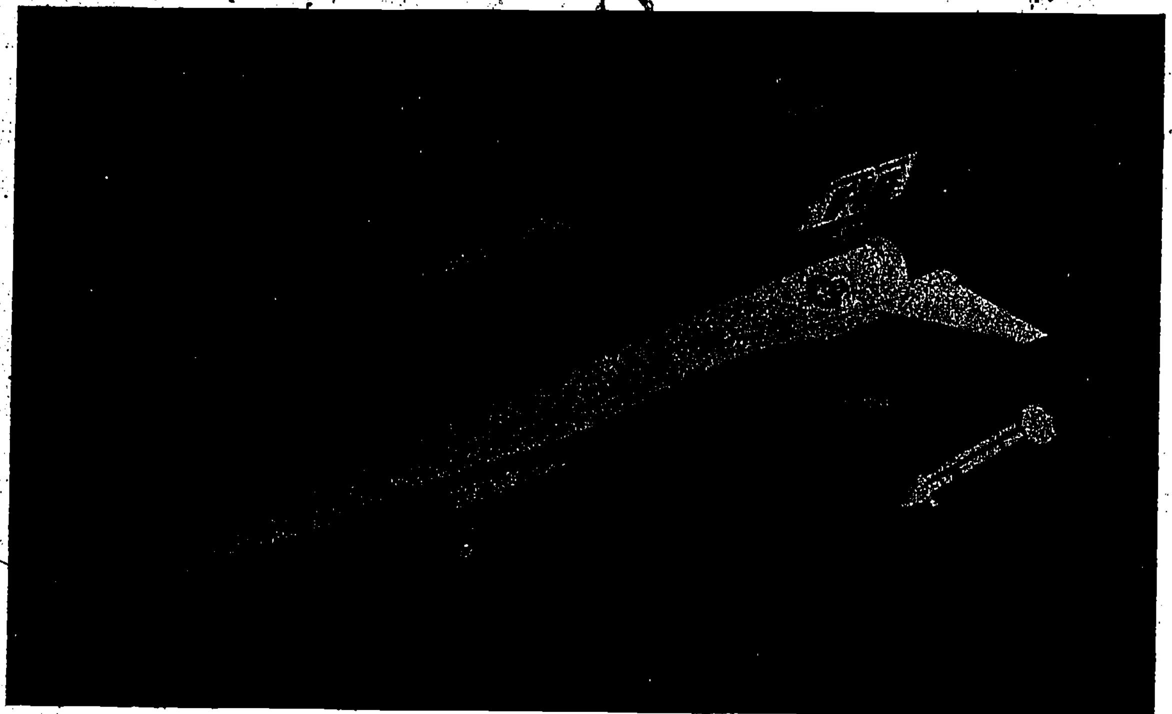
The chicken/egg syndrome comes about because a perceived economic penalty is associated with metrication. On one hand, manufacturers say a metric product will cost more. On the other hand, the Department of Defense says it does not want to bear the brunt of industry's total conversion costs. The airlines' positions are similar to Defense's: they will not request a metric airplane but will accept whatever is economically available.

Manufacturers are saying that there is just no customer demand for a metric airplane. One general aviation firm sells 50 percent of its production in the export market and has received no pressures for a metric aircraft. It envisions that its next generation aircraft, not even on the drawing board yet, will also be built to customary specifications. None of the commercial aircraft manufacturers we talked to had received orders by an airline, domestic or foreign, for a metric aircraft. In fact, foreign airlines may resist any effort to metricate since their fleets, parts, and tools are built around U.S.-designed aircraft. The Belgians, by purchasing a U.S. military aircraft (F-16) instead of a French plane (the Mirage), have demonstrated that forces in the marketplace take precedence over metrics.

According to the 1975 aerospace industry metrication report, conversion of the industry is unlikely to result from positive economic forces. Some incentives must be artificially imposed--most probably by governments--if the industry is to convert. Most of the major manufacturers we contacted agree. One major firm reports no pressures from customers for metrics and suggests that the Government may have to provide some "seed" money to get things going.

Of the 14 aerospace firms responding to our survey of the Fortune 500, 13 characterized their metric status as "meeting the demands of customers." One indicated it would attempt to block or postpone metrication. Not one company saw itself as a leader in the metrication process, nor did any see itself as following the lead of others in its industry. Industry's perception is clear--the customer will lead the way.

During the early 1970s some companies anticipated a strong, mandatory metric act with time frames for conversion and began to plan accordingly because legislation proposed at that time contained such provisions. The absence of these provisions in the Metric Conversion Act of 1975 has caused these companies to retrench. They have now joined the "wait-and-see" crowd.



F-16

PHOTO COURTESY OF NORTHROP CORPORATION.

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Government policies are important to this industry because its purchases are by far the largest market for aerospace products. For the period 1967 through 1976, Government purchases of aerospace products accounted for about 75 percent of the industry's total sales of $228 billion. If Government purchases were to be predominantly metric, the effect would be pervasive and would drastically affect the private market. There is no indication that the Federal Government will take such action. (Federal operations and policy are discussed in ch. 22.)

Coordination and plans

Nearly every company we contacted has a metric plan or policy statement. These documents are very tentative and flexible. Their contents range from general guidelines to very detailed instructions, but they all are dependent on customer demand or the introduction of an incentive that is not presently perceived to exist.

The ANMC Aerospace Sector Committee has developed a metrication plan which is updated periodically. Its plan is as tentative as the various company plans. The plan's preface states that aerospace equipment manufacturers will not likely convert in unison and that there is no industrywide metric capability now and none envisioned for the near future.

The international market

The exportation of aerospace products is very important to the industry and the U.S. economy. In 1976 aerospace exports of $7.8 billion accounted for nearly 7 percent of all U.S. exports. Foreign sales comprised about 33 percent of the industry's total sales of aerospace products, and about 50 percent of all transport aircraft on order were bound for foreign markets. Civilian exports comprise about 72 percent of the total dollar value of exports, and military products account for 28 percent.

How important are units of measure in exporting our aerospace products? In response to our Fortune 500 questionnaire, the 14 aerospace firms unanimously indicated that price, quality, reliability, and superior technology are the major factors in promoting exports. The consensus is that measurement language and/or engineering standards are of minor significance. The respondents' attitudes are shown in the table on the following page.

Significance Of Factors In Promoting Exports

Factors	Of major significance		Of moderate significance		Of minor significance		No basis to judge	
	No.	Percent	No.	Percent	No.	Percent	No.	Percent
Competitive prices	14	100	-	-	-	-	-	-
High quality	14	100	-	-	-	-	-	-
Superior technology	14	100	-	-	-	-	-	-
Good reputation and reliability	14	100	-	-	-	-	-	-
Good product maintenance and servicing	13	93	1	7	-	-	-	-
Design/manufacture of products in customary (or English) units and/or engineering standards	-	-	1	7	12	86	1	7
Design/manufacture of products in metric units and/or engineering standards	-	-	2	14	10	72	2	14

The world market for aerospace products is currently dominated by the United States and uses its customary measurement system. However, some people within the industry question how long this will continue to be true, particularly because the 1975 industry metrication report said that, as early as 1974, the United Kingdom mandated that all future military aircraft contracts would specify metric modules. An association of European manufacturers has stated that, to counter American sales in aircraft, all future commercial aircraft projects will employ metric modules.

Before the early 1970s, Brazil--a metric country--was the U.S. industry's number one export country for general aviation aircraft.

A manufacturer's association official told us that since the early 1970s Brazil has introduced some nontariff trade barriers which force U.S. manufacturers into licensing agreements. As a result, the Brazilian aircraft manufacturing industry has made a rapid advance. It has changed from aircraft assemblers to manufacturers of aircraft parts, including air frames, radio and navigation equipment, and ground support equipment. This development, plus the possibility of

international consortiums for military and commercial projects, could have major effects through technology transfers. To date, there have been no significant Trans-Atlantic Aerospace consortiums. However, such an arrangement was attempted recently between a major U.S. manufacturer and a French firm. An agreement in principle was reached to jointly build a midrange commercial passenger aircraft, but a final agreement was not completed.

However, the recent announcement by a major British aerospace company that it was not converting creates some questions. According to a U.S. aerospace industry official, this British company cited pressures from customers (airlines) as its reason for not converting, which means that in the near future new aircraft built outside the United States will be essentially customary.

Advantages and benefits questioned

The benefits of metrication most often mentioned by aerospace firms are greater standardization and rationalization (reduction in the number) of standards and parts. Other benefits sometimes mentioned include

--ease of calculations,

--opportunity to introduce better technology,

--increase of foreign sales through international standardization,

--opportunity to avoid some nontariff trade barriers, and

--pressure to seek out better designs.

Comments from the airlines, trade associations, and some manufacturers generally attest to the inevitability of metrication but deny the existence of any major economic benefits. According to some, the standardization and rationalization arguments are not totally valid. Both goals are continually sought after anyway and can be achieved without metrication. According to one aerospace manufacturer, the North Atlantic Treaty Organization needs standardization but not a metric airplane. It is also agreed that there are no benefits in a soft conversion. Soft conversion offers no hope of increased standardization or rationalization.

Of the 14 aerospace firms responding to our Fortune 500 questionnaire, 13 responded to our questions on the frequently

attributed advantages of metrication to their company. As can be seen below, opinions were rather mixed.

Opinions on Advantages of Metrication

Frequently attributed advantages	Agree No.	Agree Percent	Disagree No.	Disagree Percent	Does not apply No.	Does not apply Percent	No basis to judge No.	No basis to judge Percent
The metric system is easier to use and would result in fewer errors	6	46	6	46	-	-	1	8
Conversion will increase or protect the present amount of exports and work overseas	5	38	8	62	-	-	-	-
Conversion will provide an opportunity to standardize products	11	85	1	8	1	8	-	-
Trade will be facilitated through a common measurement language	9	69	3	23	1	8	-	-
Use of the metric system will increase production efficiencies	3	23	6	46	-	-	4	31
Use of the metric system will facilitate technological advances	-	-	9	69	2	15	2	15
Conversion will provide an opportunity for improving product standards	8	62	4	31	-	-	1	8
Conversion will stimulate your industry	-	-	11	85	-	-	2	15

No one believes that metrication will benefit its company by stimulating the industry or facilitating technological advances. Only three believe production efficiencies will improve.

There is general agreement in three areas:

--Metrication will provide an opportunity to standardize products.

--Metrication will provide an opportunity to improve product standards.

--Trade will be facilitated through a common measurement language.

Aerospace companies agree that metrication presents an opportunity to improve products and product standardization. Their responses are not an affirmation of the probability of success for achieving those goals through metrication. Product standardization and improvement are goals which receive constant attention anyway. Metrication presents another opportunity to focus that attention but, with or without metrication, some factors take precedence over these goals as shown in the program to develop an optimum metric fastener system. (See ch. 7.)

Nine of the 13 respondents agreed that trade would be facilitated through the use of a common language. This is not to say, however, that trade or exports would increase. In response to another question, all 14 firms responded and 10 said that they expect no change in exports as a result of conversion; the other 4 anticipate a slight increase in exports. The consensus appears to be that the firms see some improvements in the administrative aspects from conversion but do not see significant change in the total amount of exports.

The following table shows the 14 companies' responses to how the frequently attributed disadvantages of metrication would apply to their companies.

Opinions on Disadvantages of Metrication

Frequently attributed disadvantages	Agree		Disagree		No basis to judge	
	No.	Percent	No.	Percent	No.	Percent
Conversion will be costly	11	79	3	21	-	-
Training employees will be time consuming	11	79	3	21	-	-
Conversion will result in dual inventories	12	86	-	-	2	14
Customers will be confused by the metric system	7	50	6	43	1	7
Conversion will increase the prices of your company's products	10	71	2	14	2	14
Conversion will result in safety hazards and errors	4	29	8	57	2	14
Sales will be lost to foreign imports	-	-	12	86	2	14
Conversion of products will require retesting	7	50	6	43	1	7
Product standards will have to be changed	11	79	1	7	2	7

As indicated in the table, the consensus is that metrication will

--be costly,

--require time-consuming training,

--require dual inventories,

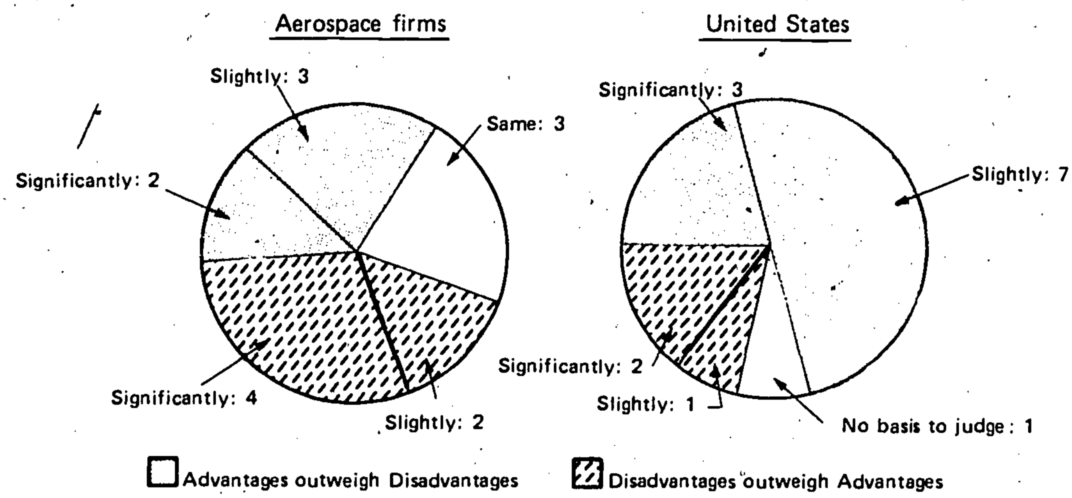
--increase the price of products, and

--require the change of product standards.

Several aerospace firms in the Fortune 500 believe that someone other than themselves will benefit from conversion. The following chart shows how the aerospace firms responded to

our questions on whether the advantages of conversion outweigh the disadvantages for their company and the Nation. Ten of the 14 firms felt that it would be an advantage for the Nation, but only 5 of the 14 indicated that conversion would be an advantage to themselves.

Weighing of Advantages/Disadvantages

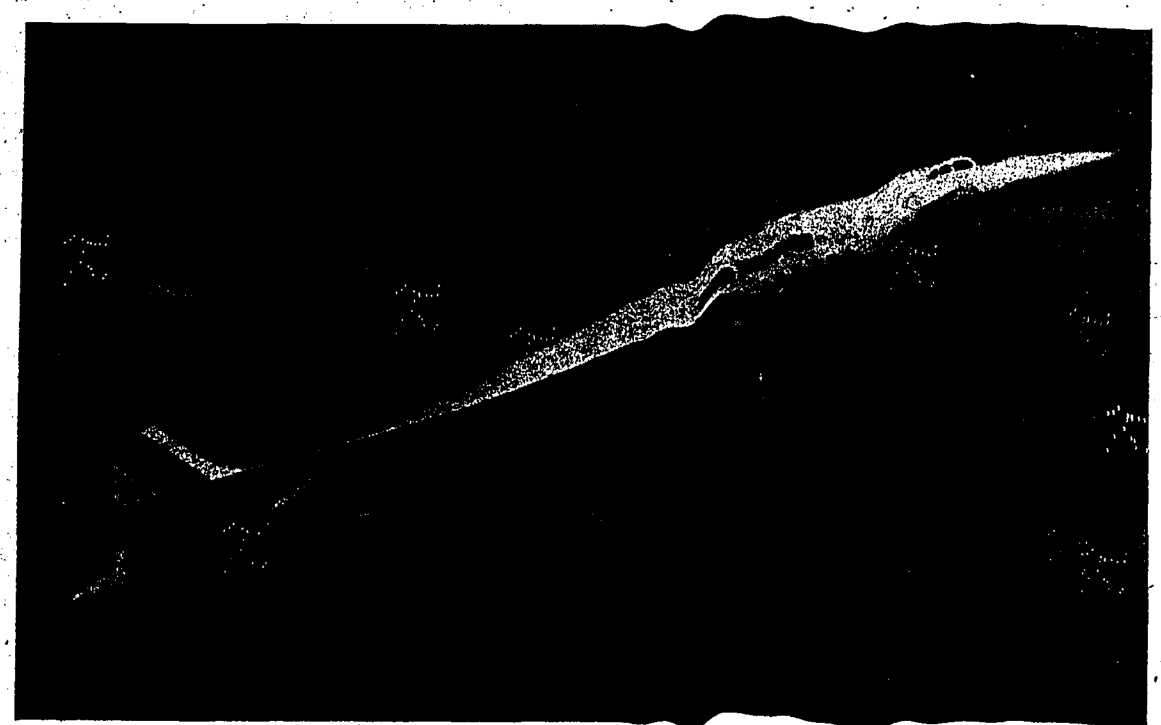


Development of metric standards-- key to metric products

Not unlike other manufacturing industries, the aerospace industry relies heavily on engineering and product standards for the development and manufacture of its products. The large manufacturers rely on thousands of suppliers and subcontractors for materials, parts, and components which make up the final product. The manufacturer controls these items through engineering standards.

The U.S. aerospace industry's standards, which are based on the customary measurement system, are essentially the world's standards. If metric dimensions are required, the standard is usually soft converted. For example, the new British-French Concorde has customary parts in many critical areas. The Concorde, sometimes referred to as a metric aircraft, has fewer metric parts than the French Caravelle, which U.S. airlines operated and maintained without serious problems a number of years ago. The new European Airbus, A-300, has a number of components built to U.S. engineering standards, according to an official of a U.S. airline which is considering buying this aircraft. We were also told that the Airbus, like the Concorde, is less metric than the Caravelle.

The airline will not have to purchase metric tools or provide metric training for its employees to operate or maintain the Airbus, we were informed.



CONCORDE PHOTO COURTESY OF AIR FRANCE.

Metricating the industry's standards

Standards rewriting in metric measures is one of the first and most important tasks facing the industry in its transition to metric measures, according to the 1975 industry metrication report. The industry has several thousand standards which cover every conceivable situation leading to the production and delivery of its products and supplies.

Whether a standard will be translated into metric units (soft converted) or a new metric standard will be developed depends on decisions made within the industry. Some groups, it is reported, believe that soft conversion is a waste of time and money because it serves no useful purpose. One major manufacturer disagrees by stating that soft conversion familiarizes engineers with the metric system.

The expected benefits from conversion of standards are the reducing of the number of standards used and improving the technology embodied in the standards, according to the majority of manufacturers contacted. However, it is also recognized that these benefits are coincidental to metric conversion. That is, either purported benefit could be attained without

conversion, but conversion provides an additional opportunity to accomplish these goals.

The number of industry standards which would have to be converted has been estimated at about 4,000. This estimate was made through a cooperative effort of the Aerospace Industries Association, the Society of Automotive Engineers, and the Department of Defense.

An initial group of 263 basic engineering standards, which have an impact on an additonal 1,500 parts standards, have been slated for conversion. Each of the above organizations has been assigned responsibility to convert some of these standards. A timetable has been established, and the conversion is to be completed by 1981. In addition, ANMC's Aerospace Sector Committee has established a log on the conversion status of the industry's standards.

Standards conversion will be a costly undertaking. Just how costly has not been determined. ANMC's Aerospace Sector Committee came up with an estimate of $29 million to convert most of the aerospace standards. This estimate was based on the conversion of 4,000 standards by 20 cooperating firms, requiring 1.16 million staff-hours at $25 an hour.

A long-term, dual inventory will exist

The life span of aircraft varies widely. Generally, manufacturers assume that an aircraft will be in use for more than 30 years. An exception to this would be military fighter aircraft which have an expected useful life of about 12 years. Inventories of parts and components for existing customary aircraft would have to be maintained for the life of these aircraft.

Because design costs for aircraft are very high, manufacturers tend to improve the basic model rather than design a new one every few years. U.S. manufacturers of the jumbo jets expect that descendants will be around for many years, at least beyond the year 2000. We were told, for instance, that the fuselage for the 757--an aircraft yet to be produced--will be essentially the same as the one for a 727.

So even if U.S. manufacturers were to metricate now, economic reality dictates that spare parts and components designed to customary specifications would have to be maintained for many years. The resulting dual inventory would be one of the major problems facing the industry and its customers.

Manufacturers wary of conversion costs

In discussions with manufacturers, a wide range of opinions on metrication costs were given. One official said that there were costs, but they were difficult to define. Another disputed this by saying that the costs of metrication can and should be computed. Another declared that it was useless to track the costs because the tracking process itself costs money and is not cost effective. According to the 1975 industry metrication report, comments on costs are usually avoided because estimates serve little useful purpose in the industry.

The manufacturers generally feel that conversion will be costly, but have conducted no cost studies to support this view. They expect to incur costs in

--converting engineering standards,

--maintaining dual inventories,

--training,

--converting computer data files,

--converting capital equipment,

--purchasing metric tools and equipment, and

--recertifying products.

The manufacturers generally expect that the costs will be managed to minimize the impact of conversion. While no overall cost estimates were available, two manufacturers told us that the cost of a metric product should not be more than 3 to 5 percent above the cost of a customary product.

We were provided some rough estimates on the cost of converting certain items. As discussed earlier, the industry may spend about $29 million to convert some 4,000 engineering standards. One small manufacturer estimated that it may spend $200,000 over a 4-year period to convert capital equipment and invest 6,000 staff-hours to convert the first aircraft operating manual and 20,000 staff-hours for another five manuals.

Certification of aircraft and parts is required by FAA. Metrication may create a need for a recertification program. We were told by one manufacturer that certification of a series of parts may cost $100,000. It may be difficult to determine whether these costs are metrication costs or normal costs, however.

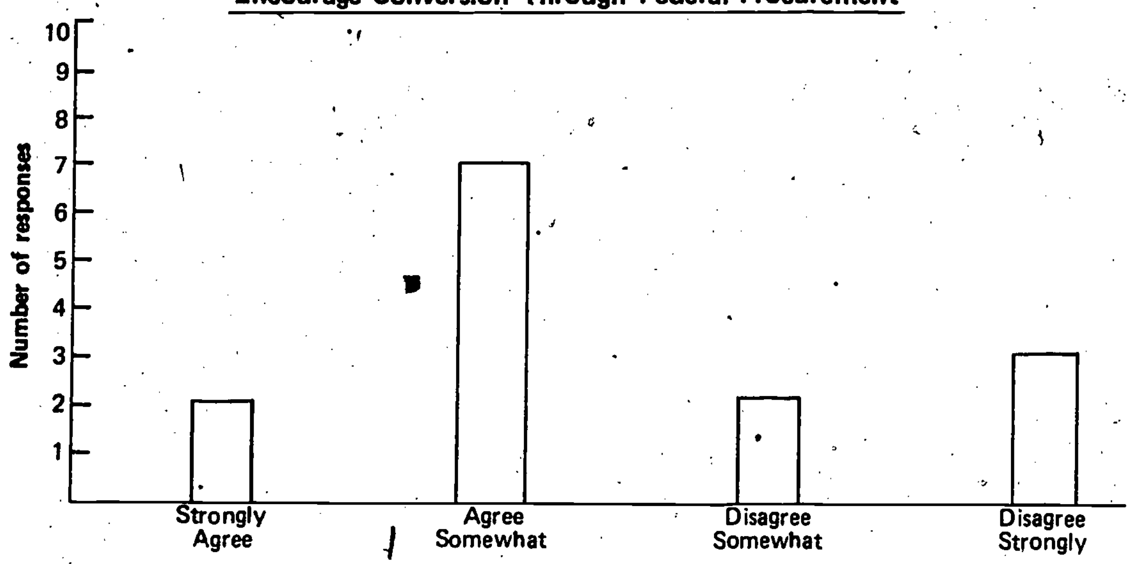
The cost of conversion could lead to increased prices of products. However, the 14 aerospace companies responding to our Fortune 500 questionnaire were split on the impact of conversion on product prices. Seven believe that metrication will increase product prices in the long run, six indicated that conversion will have little or no effect on prices, and one said prices would decrease somewhat.

Role of the Federal Government

The 14 aerospace manufacturers responding to our Fortune 500 questionnaire provided a mixed reaction to who should establish the dates for conversion and what role the Federal Government should have during conversion. Although it was generally agreed that the Government should coordinate activities and counsel and advise interested parties, only three firms indicated that the U.S. Metric Board should establish industry conversion dates if the United States converts. One firm indicated that the Congress should set the dates, five said industry associations, two said customers, and one said there was no basis to judge. Two said individual firms should set the dates.

The 14 firms were somewhat split on whether the Federal Government should use its purchasing power to encourage conversion. While there was general agreement with this position (9 of 14), there was some strong disagreement (3 firms) as can be seen below.

Encourage Conversion Through Federal Procurement



Our discussions with aerospace manufacturers led to a general opinion that the Metric Board is useful and needed, and a principle duty should be to organize metric activities within the Government. The Board should be concerned with major segments of society and not with conversion plans of individual companies. There is a need for national guidance, but first the national intent and purpose needs to be clearly identified. Additionally, the Board should not set mandates unless it is willing to help fund the program. The impetus for metrication should be consumer initiated and product oriented.

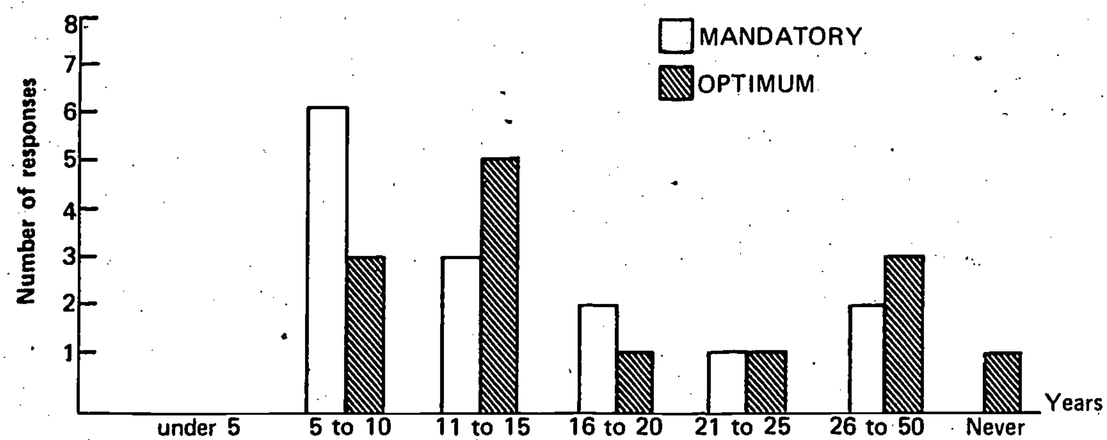
One official for a major manufacturing firm states that the Board does not need a lot of authority but that it should be able to approve conversion plans. It should have the power to motivate the "foot-draggers." In many cases there will be no economic advantage to metrication, according to this official; thus, the Board could create the motivation. The Board may need money and more legislation.

According to another official, if metric is directed from the top through Government mandates, a shorter transition period will ensue, but the process will be more expensive. If allowed to metricate solely through the marketplace, the transition period would be very long. A better course would be to have the marketplace direct the transition in the beginning. And at the end it could be centrally directed.

Timing of conversion

The following chart shows the 14 aerospace firms' attitudes in the Fortune 500 on the shortest (mandatory) time frame and the optimum time frame in which they could convert. The majority indicated that within 15 years, they could convert, whether the conversion period was the shortest or the optimum. However, many of the firms indicated that longer transition periods would be necessary. One firm indicated that if the conversion was not mandatory, a conversion period never would be optimum.

Time Frame for Conversion



CONCLUSIONS

Metrication in the aerospace industry is viewed as inevitable. However, manufacturers, customers, and Government seem to be waiting for someone else to begin the process. Use of the customary system has not restricted the industry's past performance, and conversion to the metric system is not viewed as improving the industry's sales or technology.

Air operations' safety is a major concern of the aviation community--nationally and internationally. Little is known about the implications of metrication in this area. A transition from customary to metric measures would have to be carefully planned and implemented to avoid jeopardizing safety.

The extent of metric usage in air operations is difficult to determine. Most countries register the measurement units they are using with ICAO; however, we found several instances where major countries reported using meters for altitude when they were using feet.

Certain customary units generally are used more than metric in air operations. This, as well as the safety concerns and the associated cost of converting related equipment, is keeping the aerospace industry from converting.

The total conversion cost for aviation and the aerospace industry has not been computed. If the estimates given to

convert portions of aviation and the aerospace industry are correct, total conversion costs will probably be measured in billions of dollars. Not only will the transition itself be expensive, but manufacturers foresee a long-term price increase for metric products.

No major benefits from conversion were identified which would offset the cost of converting aviation or the aerospace industry. However, no group appears to be opposing conversion. Both the aviation community and the aerospace industry expect the Government to play an important role in planning and coordinating any conversion.

CHAPTER 16

A DILEMMA FOR THE BUILDING AND CONSTRUCTION INDUSTRY

Page

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A DILEMMA FOR THE BUILDING AND CONSTRUCTION INDUSTRY

The building and construction industry is one of the largest contributors to the gross national product. In 1976 new construction was valued at $147.5 billion, about 9 percent of the gross national product. In addition, large amounts are spent each year for maintenance and repair. In January 1978 almost 4 million persons were employed in construction performed under contract.

Metric conversion in the industry is taking place at a slow rate. Major portions are not involved in metrication and have no plans to become involved. Much of the industry considers conversion to be inevitable and beneficial for the United States as a whole but is generally passive toward it.

The apparent reasons for the lack of activity are that (1) the industry presently has no compelling reasons to convert, (2) the industry is uncertain of the national policy and Federal commitment to conversion, (3) parts of the industry are concerned about the costs and not certain of the benefits, and (4) it is difficult for individual firms or segments of the industry to act alone--the industry is too diversified, and no firm is large enough to lead. Metrication of the building and construction industry probably would not occur in the near future unless it is mandated or the Federal Government plays a greater role in bringing it about.

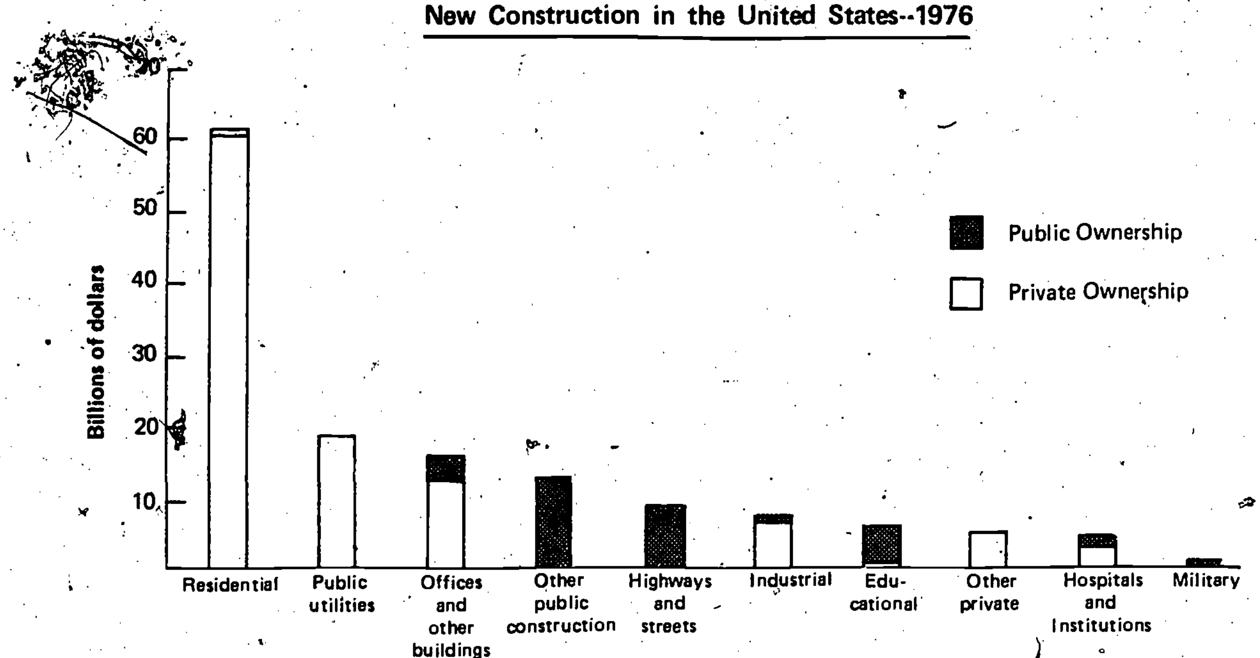
We have obtained data on the status of metrication in the industry, the advantages and disadvantages of conversion, and the implications that changing to the metric system would have. Information was also obtained on how conversion should be approached. We held discussions with numerous industry representatives, the American National Metric Council, Federal and State officials, and other knowledgeable individuals. Questionnaires (see app. I) were sent to 394 industry associations, organizations, and labor unions (hereafter referred to as associations). Replies were received from 302 associations; 285 of them were usable. In addition, 67 of the respondents to our questionnaire sent to 1,000 small businesses in various sectors of the economy were construction firms (see ch. 5). Their views have been included where appropriate.

THE INDUSTRY

As shown below, the largest single category of construction is residential, accounting for about 40 percent of total

new construction. About 25 percent of new construction is owned by Federal, State, and local governments.

New Construction in the United States--1976



The industry consists of not only those who are actually doing the building and constructing but also the individuals and firms that provide the services and materials. This includes the architects, engineers, surveyors, plumbers, brick manufacturers, labor, distributors, contractors, etc. In the broad sense, it also includes realtors, financing institutions, lumber and hardware stores, and building codes and standards organizations. The building and construction industry may be considered a collection of many related industries rather than a single industry.

Most of the industry firms are small. The Bureau of the Census estimated that in 1972 there were about 920,000 construction contractors, builders, and subdividers and developers of land for building. Only about 10 percent of the establishments had 10 or more employees. No single firm supposedly has a large enough share of the market to act as an industry leader.

STATUS OF CONVERSION

Industry's interest in metrication has increased since passage of the Metric Conversion Act in 1975. However, despite the support expressed for conversion and a general belief by much of the industry that conversion is inevitable, the industry is moving slowly toward increased use of the metric system. A large part of the industry was not involved in metrication and has no plans to become involved. As far as we could determine, no firm in the industry has converted to the metric system in its domestic operations or has definite plans to convert. One paint producer was marketing its products in metric-size containers for its foreign and domestic markets, and some of the larger construction firms and manufacturers have metric coordinators or committees. Some architectural and engineering firms and construction contractors have used the metric system to some degree in their foreign work, and some manufacturers have produced products to metric dimensions when requested by foreign customers.

The industry is primarily passive toward metric conversion. Its major metrication activities have been (1) keeping abreast of metric developments in the industry and other industries that may have an impact, (2) considering the implications that conversion would have, and (3) in some cases, working to develop a plan to be prepared when conversion becomes necessary.

American National Metric Council

The American National Metric Council has established a Construction Industries Coordinating Committee as the prime industry committee. The committee, for the most part, is made up of representatives from major industry associations. Other committees, such as the Lumber and Wood Products Sector Committee, are involved to the extent that their members provide materials and services to the building and construction industry.

The Coordinating Committee has been divided into the following sector committees: Design, Codes and Standards, Products Manufacturers, Contractors, Real Estate, Users, and Surveying and Mapping. The Coordinating Committee is to serve as a forum for discussion of issues and exchange of information and to develop an overall conversion plan for implementation by the industry. Each sector committee is to develop its own conversion plan which is expected to be widely circulated in the industry.

At the time of our study, some of the subsector committees had been in the process of forming and organizing. The

Construction Industries Coordinating Committee was working on a conversion plan for consideration by the industry. The Lumber and Wood Products Sector Committee already had a conversion plan for softwood lumber. Under the plan, lumber such as the 2 by 4 (inches) stud, which is used extensively in building, would be "soft-converted" to the nearest millimeter, 38 by 89. The 2 by 4 inches is a nominal size with the actual size being 1-1/2 by 3-1/2 inches or 38.1 by 88.9 millimeters. It is planned that nominal sizes would be eliminated at the same time that conversion takes place. Whether the 2 by 4 will be popularly known as the 38 by 89 is uncertain.

No formal action had been taken on metric sizes of panel products. It appears, however, to be the industry consensus that the standard 4- by 8-feet (1,219.2 by 2,438.4 millimeters) wood panel would be changed to 1,200 by 2,400 millimeters, a reduction of about 3/4 inches in width and 1-1/2 inches in height. We were told by industry representatives that production machinery can be easily converted to produce the size without much expense. Some production efficiency or plant production would be lost because a smaller size is being produced, and there would probably be a slight increase in cost per square foot. Rooms in houses built with the smaller panel may also be smaller with lower ceilings because panel size usually determines room size to an extent. No agreement has been reached on panel thickness because a change in thickness may require retesting to determine whether the product would still meet building code requirements.

The Lumber and Wood Products Sector Committee anticipated no further significant action until it appears that conversion is necessary. The committee did not believe that conversion would be beneficial to the lumber and wood products industry and will take no action that would force it.

About 25 percent of the lumber used in the United States is imported from Canada. This is about 60 percent of Canada's lumber production. There is, however, little trade in wood panel between the United States and Canada.

The Canadian construction industry has established January 1, 1978, as the date for the start of metrication. To meet both the U.S. and Canadian markets, the Canadian lumber industry will continue to produce lumber in existing sizes, lengths, and grades but market it in metric measurements, a soft conversion, in Canada by September 1, 1979, and in customary terminology in the United States. Final decisions on lumber sizes will not be made until the United States converts. The industry will produce the 1,200 by 2,400 millimeters wall panel on demand for the Canadian market after January 1, 1978.

Associations

Only a few industry associations have progressed beyond the establishment of a metric coordinator or committee and approval of a metric policy. As shown in the following table, a substantial number of associations responded to our questionnaire that they have no plans for key metric activities.

Industry Associations' Status of Metrication

Metrication activity	Completed	In process or plans for	No plans for	No basis to judge/does not apply
	----------(percent of associations)----------			
Metric policy statement	18	18	52	12
Metric coordinator or committee	24	24	41	11
Member survey	8	14	61	17
Associaton funds budgeted for conversion	5	14	66	15
Conversion cost analysis	2	7	71	21
Metric training of members	2	24	61	13
Standards in both customary and metric	6	38	41	16
Soft conversion of standards	4	27	46	22
Hard conversion of standards	1	17	56	26
Consumer information	2	20	57	21
Decisions on design dimensions and/or product sizes	4	27	42	27
Timetable for conversion	2	16	66	16
Coordination with industry	4	46	39	12
Coordination with government	2	33	48	17

While many associations have given little, if any, consideration to metric conversion and had no plans to do so, some associations have been involved for varying reasons. The American Institute of Architects, for example, has formed a metric task force that is developing a metric practice guide for building design and construction. The document will address aspects, such as preferred sizes for building, the impact of conversion on building products, and metric drawing scales and convention. The 1980 edition of the

Architectural Graphic Handbook is to have a chapter on the metric system, and the 1985 edition may be in metric, depending on status of metrication in the industry. The Institute, however, has supported metrication as beneficial for the industry since 1944. Resolutions in favor of conversion were passed in 1973 and 1975 while metric legislation was being considered.

The National Paint and Coatings Association, which represents about 1,000 firms in the paint industry, has been involved in examining the impact of metrication since 1972. It believes that metrication offers no economic advantage to the paint industry and will have a substantial cost impact. However, the association considers metric conversion inevitable, primarily because some of the industry's major customers, such as the automobile industry, are expected to begin ordering paint in metric quantities. As a result, its metric activities are oriented toward helping its members anticipate metrication problems, coordinate conversion, and minimize costs.

The association has recommended that member firms give both the customary measurement and metric equivalent for contents on their paint cans until it becomes necessary to convert to metric-size cans. The following metric can sizes have been recommended:

--4 liters to replace 1 gallon.
--1 liter to replace 1 quart.
--500 milliliters to replace 1 pint.
--250 milliliters to replace 1/2 pint.
--125 milliliters to replace 1/4 pint.

The metric can sizes would be about 6 percent larger than the customary sizes.

Although many paint manufacturers are showing both the customary and metric equivalents for contents on their paint cans, during our review we identified only one manufacturer that marketed paint in metric-size containers for the domestic market. About 2 years ago, the firm began using containers of 1, 4, and 20 liters in size for export. A representative of the firm believes that customary containers are not very marketable in metric countries and that conversion has given his firm a competitive edge in foreign countries. The firm also decided to sell paint in the domestic market in metric cans. Some customer resistance to the metric cans was expected, but none developed.

The firm's exports account for 10 to 20 percent of its total sales compared to about 2 percent for the industry as

a whole. This firm is able to export because it produces high quality stains and other specialty items which do not have a great deal of competition in the foreign countries. Paint generally is not considered an exportable item. Shipping costs make the price of the paint less competitive with local producers in foreign countries. The export market is not important to most paint manufacturers. Some large producers have production plants in foreign countries that market paint in metric cans.

A representative of another paint producer that does some exporting said that exporting in customary containers had not affected his firm's sales, but he anticipated that at some time in the future foreign countries will require metric containers.

A potential problem exists for the paint export market. The paint can sizes used in most metric countries would not be the same as those proposed by the National Paint and Coatings Association. For instance, most of Europe uses a 5-liter rather than the proposed 4-liter can.

None of the other paint manufacturers we talked to had plans to convert unless it was made mandatory or market pressures forced them to. The one firm using metric-size cans in the domestic market had no plans to convert its production and other internal operations.

Small construction firms

In our questionnaire to small businesses we asked the current status of three major metrication activities. The small construction firms responded as follows.

Metrication activity	Completed	In process or plans for	No plans for	Does not apply
	------------(percent of firms)------------			
Estimate cost to convert	-	6	79	15
Convert or develop products in metric sizes	-	5	74	21
Convert or obtain equipment in metric sizes	-	9	82	9

Thus, very few of the small construction firms appear to be involved in metrication, and a large percentage have no plans to become involved.

FEDERAL ACTIVITY

The Federal Government is the building and construction industry's largest single customer, accounting for about 5 percent of total new construction. It exerts additional influence on the industry through grants for construction of hospitals, highways, airports, etc., and housing and home mortgage loan guarantee programs.

We discussed metrication activities and plans with several of the major construction agencies. Although activities varied, the general consensus of the construction agencies was that they must keep pace with the construction industry but not lead or attempt to force the industry into converting. Several agency officials told us that there is little metrication activity in the industry.

Army Corps of Engineers

The Corps of Engineers had no plans to unilaterally change to metric construction. Corps officials indicated that they cannot force the construction industry to convert because the Corps represents but a small segment of the construction market. No construction industry suppliers had approached Corps officials with offers of metric products. The Corps officials believed that it would be costly to convert the construction industry and that, if the Corps used metric measurements for a new design, such as for a building, costs would increase. In addition, the officials were concerned that the industry may not be able to produce the required metric products. The officials further said that if the Corps issued a request for proposal for metric construction, no firms would offer bids.

Corps officials did not view soft conversion as beneficial. They indicated that the Corps must use the same measurement system as the construction industry.

Bureau of Reclamation

The Bureau of Reclamation, Department of the Interior, had interpreted the overall department policy as one of converting to the metric system by 1980. Bureau officials plan to implement the policy with one overriding consideration--it will keep pace with rather than lead the industry. A Bureau official said that the construction industry had slowed its metrication because of a delay in the establishment of the

U.S. Metric Board. His opinion was that the Bureau should not use its purchasing power to prod the industry into converting but that the industry should take the initiative.

Metric committees have been formed in the various Bureau organizational elements. Each employee had received two 2-hour metric training sessions with more extensive training for some employees.

As of December 1, 1977, metric specifications had been exclusively used in four instances: two dams, an electrical substation, and equipment to be used in a desalting project. The specifications for the desalting equipment will be a soft conversion. The survey and design data for the substation and dams will be in metric. The design and engineering drawings will give only metric measurements, but each drawing will have a table listing each dimension on the drawing and its customary equivalent. The projects will actually be a combination of hard and soft conversion. Specifications for standard items, such as a concrete block, would give the metric equivalent of the standard customary-size block. Pipe may have a hard metric length, such as 12 meters, with the diameter the metric equivalent of one of the standard customary diameters. The bidding on the first of these contracts should take place sometime during the early part of 1978.

Also, the Bureau had previously awarded two clearing and fencing contracts for which the specifications were a combination of customary and metric. The fence was in metric lengths with customary wire gauges. The fence posts were standard customary posts with their length in hard metric.

A Bureau official told us that the Bureau is beginning metrication because its programs for developing water resources span so many years from design to completion of construction. He said the additional costs for these projects are insignificant because the Bureau is not demanding metric materials. The contractors may spend a little extra time with the specifications because of their unfamiliarity with the metric system. The number of bidders on the contracts were not expected to decrease because the projects are in metric.

Naval Facilities Engineering Command

The Naval Facilities Engineering Command, which is responsible for procuring all Navy construction, is the largest single preparer of military and Federal construction-related specifications. Many of its specifications are used by other Federal agencies and State and local governments.

The Command had no plans for soft or hard conversion in its construction specifications, which are in customary units.

A Command official indicated that construction specifications would be in metric in line with any construction industry plans to convert.

Tennessee Valley Authority

The Tennessee Valley Authority did not have a formal metrication policy. It is neither for nor against metrication. Authority officials said that the Authority plans to keep pace with industry and other Federal agencies but will not take a lead. Design and construction is done in customary units; no plans to specify construction are in metric.

Veterans Administration

The Veterans Administration had not specified metric construction and had no plans to do so. Its policy is to specify and use available materials. An agency official told us that the Veterans Administration would not take a lead role in metrication because it does not have a large enough part of the total construction market. The official said that he had not seen a push toward conversion in his contacts with the industry.

National Bureau of Standards

NBS's basic stated objectives for its Center for Building Technology are to develop and advance building technology by providing technical and scientific information which can be used to improve the usefulness, safety, and economy of buildings while conserving building materials and energy. The Center also aims to encourage the use of improved technology by the building community.

The Center's major metrication activities have been (1) collecting data on the activities of international standards organizations and the experiences of other countries that have been involved in metrication and (2) providing assistance on metrication to the industry and other Government agencies. The Center is providing technical assistance and serving as the secretariat for three of the seven American National Metric Council construction sector committees--Design, Codes and Standards, and Products Manufacturers. In addition, the Center has prepared several reports on the impact of conversion and provides lecturers to interested groups.

A technical consultant to the Center on loan from the Australian Government has prepared an NBS report entitled "Recommended Practice for the Use of Metric (SI) Units in Building Design and Construction." The paper has been

approved by the American Society for Testing and Materials as a voluntary national standard. The consultant was working on a draft standard which is to describe the methodology for arriving at preferred metric dimensions and product sizes for construction. It is planned that these two standards would be available for use by the industry if it converts.

Department of Housing and Urban Development

A Department of Housing and Urban Development official told us that the Department does not have a metrication policy and is generally inactive with regard to metrication. The Department insures housing mortgages and loans and provides subsidies, but it does not contract for construction except for a few demonstration housing units. It has certain minimum property standards, and the housing constructed under Department programs is built to its standards. The Veterans Administration and the Farmers Home Administration also use the Department's minimum property standards in their housing programs. The Department believes that changing these customary standards to metric is forcing metrication on the owners of the housing.

General Services Administration

The Public Building Service of the General Services Administration developed a position paper on metrication which states that in construction it will follow the lead of national consensus standards organizations, such as the American National Standards Institute and the American Society for Testing and Materials, in developing metric standards and specifications. Such organizations have broad representation of both user and producer interests in the industry.

A Public Building Service official said that metric building standards have not been developed, and a single agency, such as the General Services Administration, cannot force the building and construction industry to convert. He said that conversion by the agency would not have an effect on the industry.

NO COMPELLING REASONS TO CONVERT

The industry presently has no compelling or pressing need to convert in that (1) metrication is voluntary, (2) the industry can still obtain customary materials without any difficulty, (3) customers are not demanding metric products, and (4) the industry exports very little and those we contacted which were involved in exporting generally did not view the measurement system as a significant factor in exports. Without a compelling reason to convert, many in the industry are

reluctant to make the change. Machinery, tools, products, codes and standards, and so forth are predominantly in the customary system. The industry is familiar with the customary system and has been successful with it.

International trade

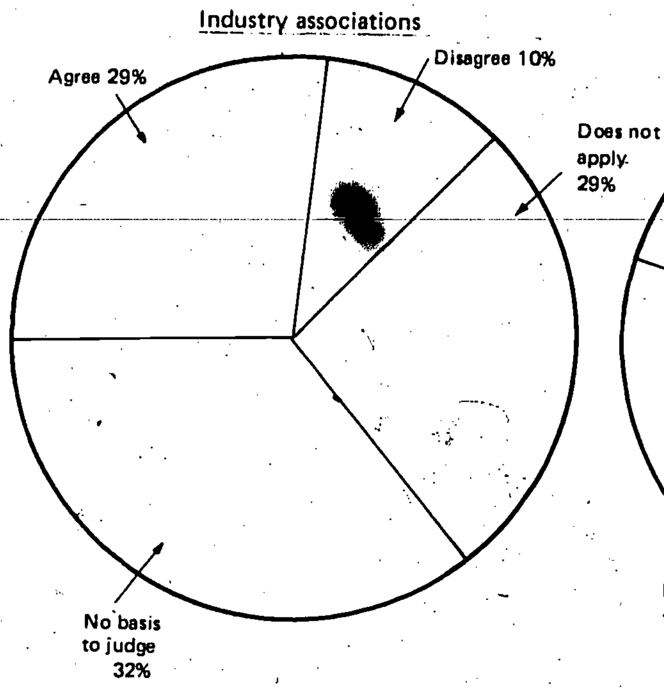
The anticipated positive effects of metrication on international trade was often cited by building and construction industry representatives as a compelling reason for the United States, as a whole, and for some selected industries to convert to the metric system. The primary reason for this belief is that nearly all countries are metric, and U.S products designed and produced in the customary system will not be readily accepted in metric countries.

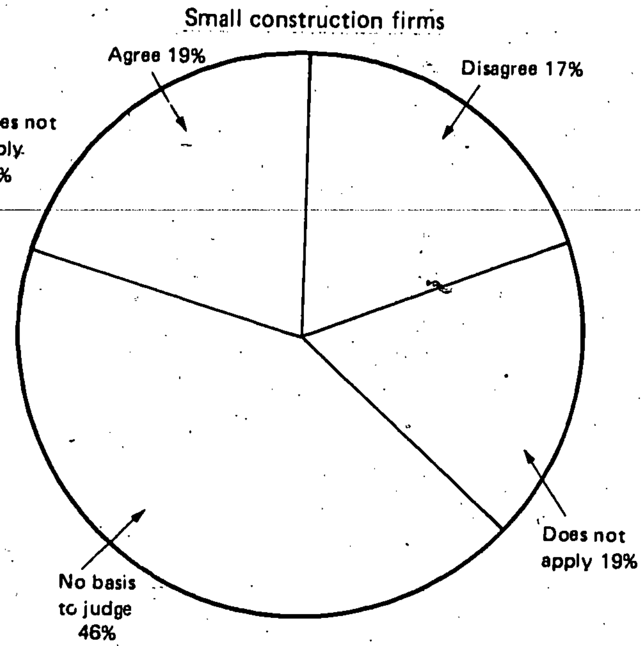
The impact that metric conversion would have on the building and construction industry's exports is unknown. However, more industry associations and small construction firms in responding to our questionnaire agreed than disagreed that conversion would increase or protect the industry's present amount of exports and work overseas. In both cases, as shown on the following page, the largest number indicated that they did not know or that the statement would not apply. The majority of the associations did believe that trade would be facilitated or made easier by metrication.

Many industry representatives we talked to, however, did not consider international trade to be a compelling reason for the building and construction industry itself to convert, because it primarily has a domestic market. Only a small amount of building materials is exported, and there does not appear to be much potential for increased exports of products such as brick and concrete block. Tariffs may also limit the potential. For example, a Canadian Wood Council official told us that there is almost no trade in wood paneling between the United States and Canada because of tariffs. In addition, we were told by several firms and associations whose members are involved in international trade that the measurement system is not a significant factor in international trade of building products or technology. Such factors as price, quality, reputation, tariffs, and nontariff barriers are the significant factors. If demanded by customers, product manufacturers will provide products with metric dimensions and construction firms will build metric buildings.

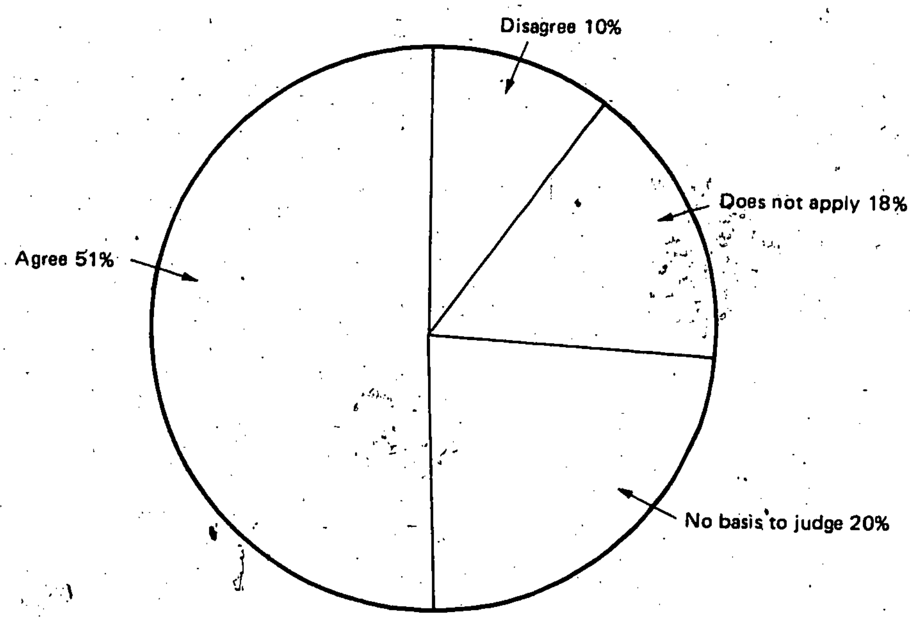
We discussed metric conversion with five of the largest U.S. design and construction companies that do substantial foreign work. Representatives of these firms generally believed that conversion would not have a significant impact on the amount of their foreign work. They indicated that the

Conversion Would Increase or Protect Exports





Trade Would be Facilitated



NOTE: Totals in the above and following charts in this chapter may not add up to 100 percent because of rounding.

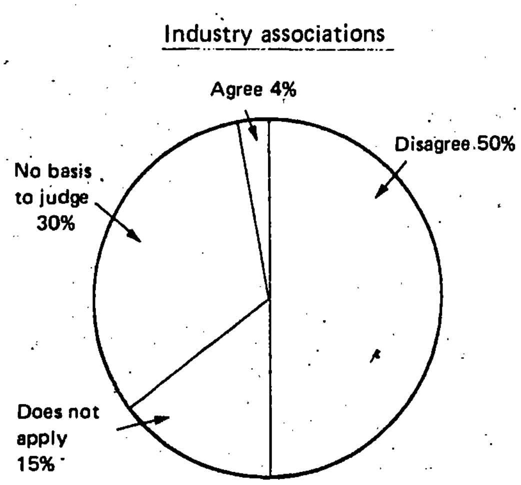
United States being customary had not impeded their efforts to win foreign contracts.

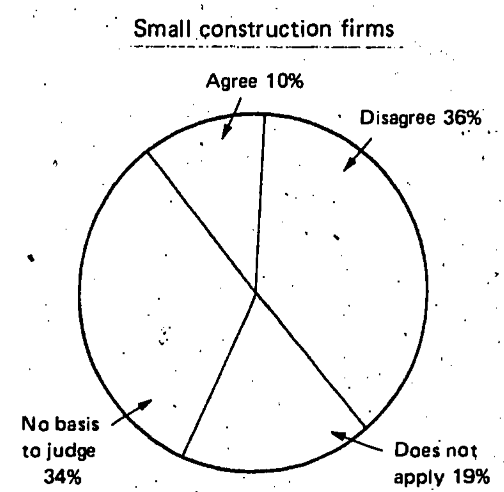
U.S. construction firms appear to be very competitive with those of other countries in bidding on foreign construction contracts. According to the Engineering News Record, 109 of the top 400 U.S. construction companies were awarded contracts totaling $15.6 billion in 1976 for projects in 110 countries. Of the top 500 design firms, 172 firms billed foreign clients in 133 countries for $637 million.

Another factor to consider in examining the impact of metrication on exports of building products is whether the metric sizes that would be produced in the United States would be the same as the standard in other countries. A member of the ANMC Lumber and Wood Products Sector Committee told us that he did not believe that metric conversion would make much difference in exports. In wood paneling, for example, a wide variety of sizes are used in other countries. The 1,200- by 2,400-millimeters size which the U.S. industry would probably adopt is fairly common in Europe, but West Germany was using a 1,250- by 2,500-millimeters panel and Japan was using a 900- by 1,800-millimeters panel. The representative further said that the U.S. industry has done well in foreign markets with its customary sizes and that these sizes have not been a problem in international markets because dimensions are not that critical.

Only a small percent of the associations and small construction firms believed that sales would be lost to foreign imports if the industry converted. Again, a large percentage had no basis to judge or said that the statement would not apply.

Sales Would be Lost to Foreign Imports Because of Conversion





No one to take the lead

The construction industry may be fragmented and diversified, but the various industry segments are highly interdependent. As a result, no firm or segment appears willing to take the first step and metricate because of economic consequences if the timing is wrong. For example, the size of brick, concrete block, wood panel, and gypsum board are coordinated. If a manufacturer or group of manufacturers of one of these items changed to a metric size, the imcompatibility of the product with the others would probably result in lost sales. The demand for the customary product would be met by another manufacturer.

An example of this already occurring is the case of a firm that provides home design plans and construction drawings. The firm began to dual dimension (give both customary and metric dimensions) its drawings a couple of years ago because the firm believed that conversion was imminent. Building contractors did not understand what the metric dimensions were, and as a result, sales began to decline. The firm decided to revert to showing only customary dimensions. A representative of the firm said that a large education program would be needed before conversion.

Designers do not plan to design in metric or specify metric-size materials until the metric materials are available. Product manufacturers do not plan to produce metric materials until they are specified by the architects. Contractors cannot build metric buildings without metric designs and materials. A coordinated, industrywide effort, including Federal participation, would be needed if conversion is to occur. As discussed later in this chapter, some proponents of metrication have proposed that the Federal Government specify construction in metric to create a market for metric materials and design.

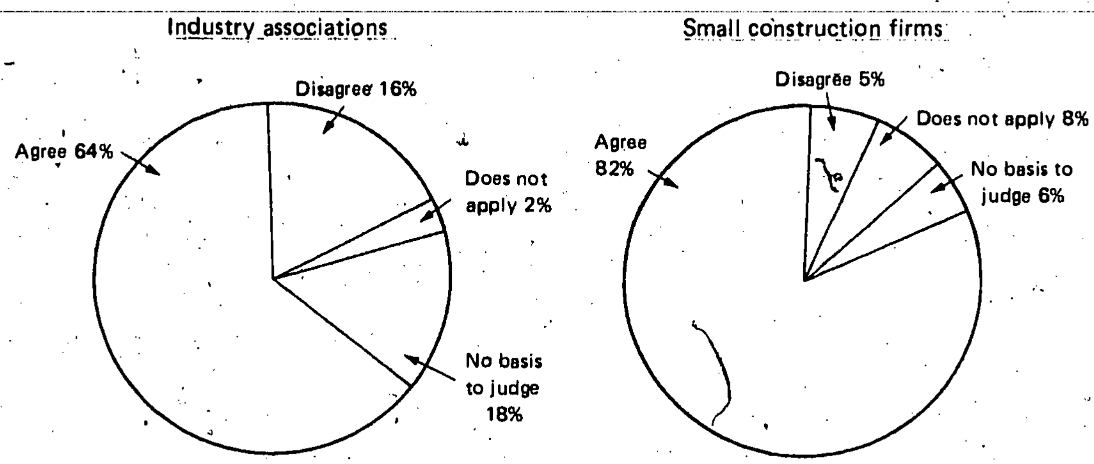
METRICATION WOULD PRESENT MAJOR PROBLEMS FOR THE BUILDING AND CONSTRUCTION INDUSTRY

The proposed disadvantages of metric conversion generally pertain to the costs involved in converting production equipment, training personnel, maintaining dual inventories, converting building codes, retesting of building products and lost time and efficiency while adapting to a new measurement system. (The cost of converting building codes and retesting of building products are discussed in a later section of this ch.) Concerns have also been expressed that conversion would be confusing to customers. Little conversion cost data is available, but nearly all firms and segments of the industry would bear some costs of converting. Some anticipate substantial costs.

Conversion would cost but the impact would vary

Most associations and an even larger percentage of the small construction firms indicated in the responses to our questionnaire that conversion would be costly.

Conversion Would be Costly



Conversion costs would vary by sector of the industry and firm. For example, it is not anticipated that conversion costs for an architectural firm whose major conversion costs would be for such items as purchase of metric drawing scales, staff training, dual inventories of stock plans, and revision of technical publications would be as high as those for a manufacturer which, in addition to facing problems of training and dual inventories, must make machinery adjustments to produce new metric-size products. The extent of the costs depends on the type of operation and the manner in which metrication takes place.

Metrication would probably have the greatest initial cost impact on the manufacturers of building products because of possible equipment changes and dual inventories. The case of the concrete block and brick industries draws an interesting contrast. The concrete block industry has already expressed concerns about conversion costs while there seems to be little cost involved for the brick industry.

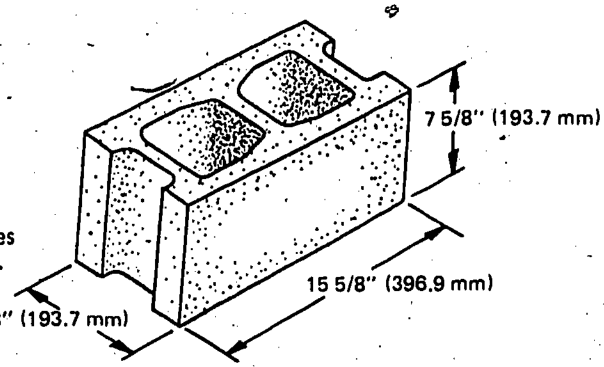
Concrete block industry

In 1974 the U.S. concrete block industry consisted of about 1,600 plants producing about $1 billion of block. According to the National Concrete Masonry Association, about 80 percent of concrete block manufacturers are small, family owned businesses with one production plant. The industry is

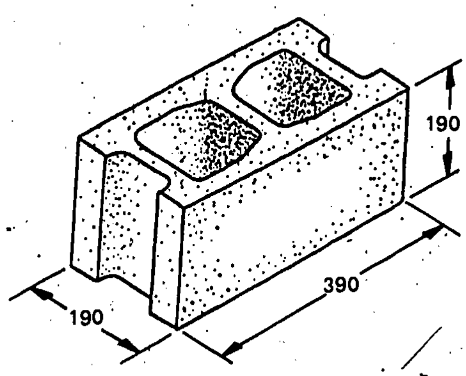
decentralized with a typical marketing area being within a 30-mile radius of the plant in the Eastern United States and up to 200 miles in some parts of the West. There is almost no exporting of concrete block.

The standard concrete block has a nominal size of 8 by by 8 by 16 inches. The actual size is 7-5/8 by 7-5/8 by 15-5/8 inches with the 3/8 difference being an allowance for mortar. Metric-size block is expected to be in multiples of 100 millimeters, as are other products, such as brick and paneling, that block sizes are coordinated with. The standard metric block probably would have actual dimensions of 190 by 190 by 390 millimeters and a mortar allowance of 10 millimeters. This is only a slight change in size from the standard customary block which in millimeters would be 193.7 by 193.7 by 396.9 with a mortar allowance of about 9.5 millimeters. However, the difference is considered by industry representatives to be large enough that block sizes would no longer be coordinated with proposed metric sizes of brick, paneling, etc., and the difference is too large to eliminate by reducing the amount of mortar.

STANDARD CUSTOMARY BLOCK
dimension in inches and millimeters



STANDARD METRIC BLOCK
dimension in millimeters



To produce the metric-size block, industry representatives believe that new mold sets, the parts that fit in the molds, and machinery replacement parts would be needed. In 1970 the National Concrete Masonry Association estimated that conversion would cost about $100,000 for each of the then 2,000 block plants for a total cost of about $200 million. This estimate was based on an "overnight" or sudden conversion. If conversion takes place over a more extended period, the replacement costs for molds and sets of parts would probably be less but the problem of dual inventories would be greater. Moreover, some confusion and mistakes may occur because the metric and customary blocks would not be distinguishable with the naked eye but are not compatible when used in construction.

A December 1975 study of the effects of metric conversion on the Canadian concrete block industry was performed by a private consulting firm for the National Concrete Producers' Association of Canada. It was estimated that conversion would cost the concrete block industry in the range of $6.7 million to $7.7 million. The greatest portion of the estimated cost was for new molds, sets of parts, and an initial supply of spare parts. The cost of producing metric technical literature was not included.

The U.S. National Concrete Masonry Association has reviewed the above study and considers it to be comprehensive and applicable also to the U.S. industry. Some industry representatives believe that because the U.S. population is about 10 times greater than that of Canada, the cost for the U.S. concrete block industry may be 10 times larger. Thus, the estimated costs could be in the range of $67 million to $77 million.

One concrete block producer estimated that conversion costs of $100,000 amortized over a 3-year period would increase the firm's block prices by 10 percent. He expressed concern that the increased prices may induce customers to use other materials such as wood, brick, steel, and glass. The Canadian concrete block industry also expressed such fears, but the new metric block will be produced on demand after January 1, 1978, in accordance with Canada's metrication plan/ Canada's experiences should prove beneficial to the United States.

Brick industry

The brick industry which is, in some cases, in direct competition with concrete block has substantially fewer producers and a usual marketing range of 150 to 200 miles. Brick also is seldom exported.

Presently, the standard modular brick has actual manufactured dimensions of 3-5/8 by 2-1/4 by 7-5/8 inches, which permits a mortar allowance of 3/8 inch. During production, most brick is extruded in continuous lengths and cut into desired sizes rather than produced in molds. Only 10 to 15 percent of brick is made in molds, primarily for special effects.

Present thinking is that the standard modular metric brick would be 90 by 57 by 190 millimeters. The size of the new brick would be about 4 millimeters shorter in length and about 2 millimeters less in thickness or depth, actually within the permissable tolerances of present specifications. The height would remain about the same. According to an industry representative, this slight change, however, probably would be made on converting, but the cost of making the change would be small.

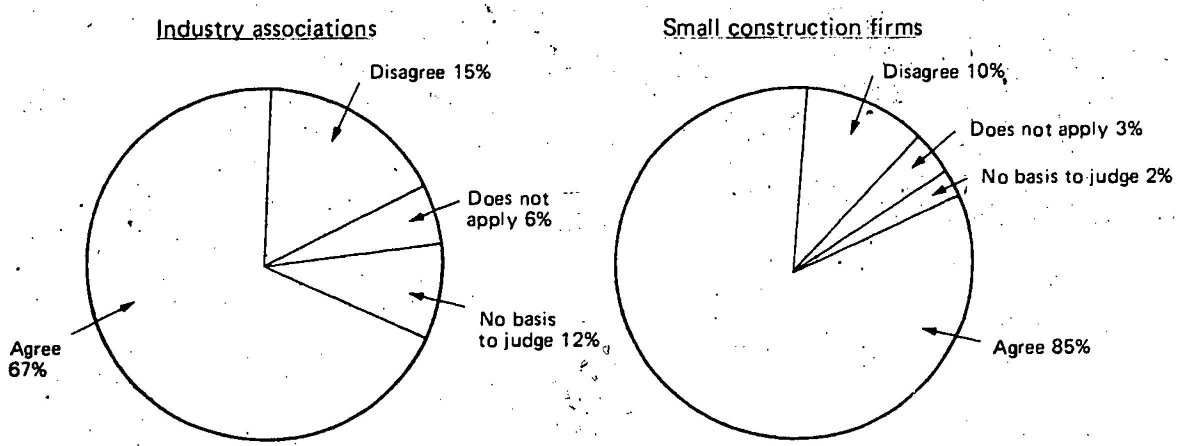
Conversion of brick (extruded-type) would require changing the equipment parts that shape the brick as it comes out and the wire that cuts it into the desired sizes. An industry representative told us that this would cost about $2,500 per machine, and the impact would be minimal because conversion could take place when these parts routinely wear out.

Metric training

Metrication would require that the industry's employers and employees understand the metric system well enough to perform their jobs. The extent of the knowledge of the system would depend on individual duties and responsibilities.

As shown on the following page, a large percentage of association officials and representatives of the small construction firms responding to our questionnaires believed that employee metric training would be time consuming.

Employee Training Would be Time Consuming



A comprehensive program designed to teach employees the metric system could be time consuming and expensive. A program to familiarize employees with the system on a need-to-know basis would probably be less costly. Metric educational material put out by others, such as the U.S. Metric Board and educational organizations, should help in any training program selected. The time used for metric training would be time away from normal duties and probably would lessen production to this extent. This is also a training cost.

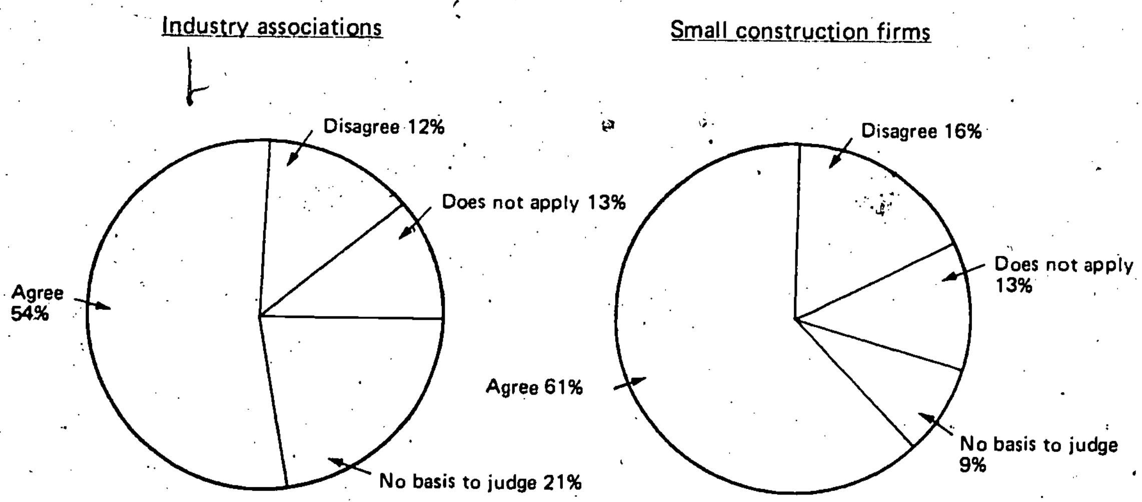
Some labor groups consider the approach of familiarizing employees with the metric system on a need-to-know basis to be unacceptable because it could limit the ability and flexibility of the work force and narrow and depersonalize the worker. They call for the establishment of special metric training programs that are continuing, flexible, and designed to assure employees continued full participation in the work force with no diminishing of future opportunities. Such programs, however, could substantially increase conversion costs for the industry.

Dual inventories

In this context, dual inventories refer to a situation in which both a metric and a customary size of a product is maintained in a firm's inventory. For example, the industry's production of both the 4- by 8-feet wall panel and the 1,200- by 2,400-millimeters panel would result in dual inventories. Invetory probably would not be double because use of the customary product could be phased out over a period of time in favor of use of the metric product. Not only building products, but equipment parts, molds, home plans, design drawings, etc., could be affected.

According to our questionnaire responses, as can be seen by the chart below, many of the associations and small construction firms consider dual inventories to be a significant disadvantage of metric conversion.

Conversion Would Result in Dual Inventories



According to industry representatives, costs to the industry would result because of requirements for additional storage and shelf space and handling, and more adjustments in production equipment to produce the greater number of sizes may be necessary. Potential for errors in ordering and shipping materials would increase because the metric size of many building products is not easily distinguished from the customary size by the naked eye.

Another dual inventory problem may result if replacement parts are needed for items that were designed and constructed to customary measurements. If customary parts are not obtainable and metric parts cannot be easily adapted, the use of these items may be discontinued before they normally would. This would be a cost to the owner of an item.

Housing is an example where the dual inventory problem may occur. The existing inventory of houses is about 80 million. About 1 percent, or 750,000, of these disappear each year because of demolition, changes in their usage, fire, floods, conversions, etc. In 1976 alone, 1.1 million houses were added to the inventory. Thus, it is apparent that a substantial number of houses built to customary dimensions will be in use for many years. According to an NBS official, 100 years is generally used in making housing stock projections as the average life of a house. Over the years, many houses

are repaired and remodeled and additions are added. In many cases, customary materials would be desired.

Some in the building industry do not believe that customary materials would be routinely produced after a short transition period. Homeowners would have to make do with metric materials or pay a price premium for special-made materials. Others indicate that the demand for customary materials would be large enough that some manufacturers could continue to produce customary products.

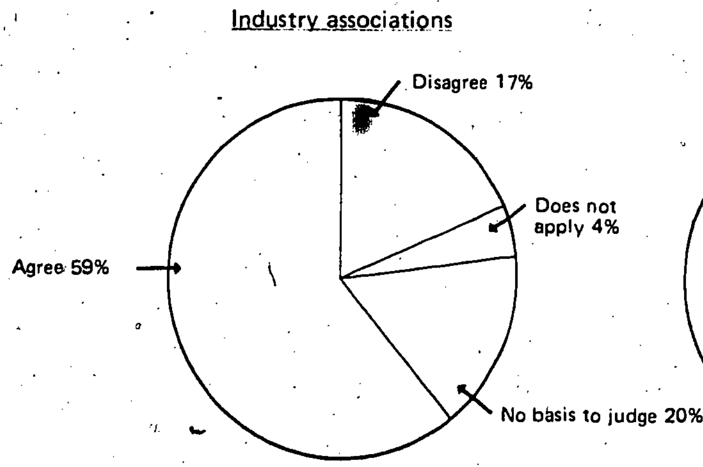
Lumber and hardware stores may have a special problem with dual inventories in that they deal with building contractors and the homeowners, primarily in replacement materials. More shelf space would probably be required because there may be a demand for both metric and customary materials. Hardware stores already experience a shortage of shelf space. The stores may also experience some customer dissatisfaction if they are unable to obtain customary materials for them at a reasonable price.

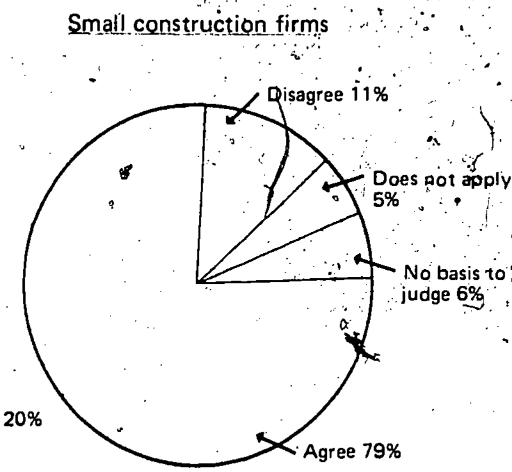
It appears that dual inventories would be one of the most costly problems of conversion and a major concern of the industry. Many sectors of the industry would want the shortest feasible transition period. Some sectors may wish to extend the period to alleviate some of the costs of equipment adjustments and replacements. This conflict would have to be settled to implement an effective, coordinated conversion program.

<u>Customer confusion</u>

Changing product sizes, architectural and engineering drawings, sales catalogs, and so forth to metric could cause confusion for customers until they are familiar with the new system. In this regard, the associations and small construction firms responded to our questionnaires as follows.

Conversion Would Cause Customer Confusion





Such confusion could mean that a firm's employees would have to spend more time with the customers to help them overcome their confusion, more errors may occur, and those that convert may lose business unless all competitors convert at the same time.

Those segments of the industry that deal directly with the public may be affected to a greater degree. An official of the National Association of Realtors, for example, told us that a major disadvantage of metrication for realtors would be dealing with home buyers who do not have a full understanding of metric measurements, such as the number of square meters in a room. The official thought that conversion should consist of an extensive period of using both customary and metric measurements and a large education program to teach the metric system to the public.

BENEFITS ARE UNCERTAIN

The proposed benefits of converting to the metric system can be divided into two categories. The first is the direct benefits that the industry may accrue as a result of the change from use of the customary system to the metric system. The other category is the opportunities available during such a change to bring about improvements in building and construction practices, eliminate unneeded product sizes, and so forth.

Direct benefits

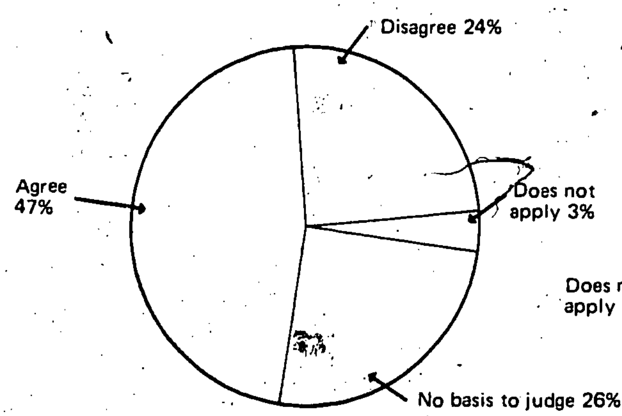
Proported direct benefits of metric conversion would be those resulting because (1) use of the metric system would

reduce time and the number of errors in calculation and estimating and (2) others are using the metric system. The latter would primarily relate to international trade but also to transfer of information and technology.

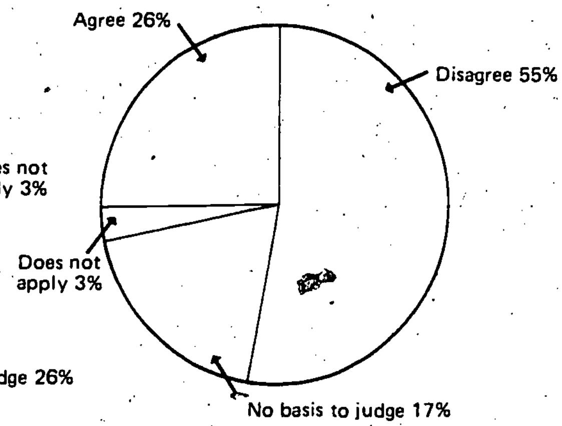
According to our questionnaire results, the industry is divided on whether the metric system is easier to use and would result in fewer errors.

Metric is Easier to Use and Would Result in Fewer Errors

Industry associations



Small construction firms



The associations representing Designers and Contractors had the largest percentage of those who thought the metric system is easier to use and would result in fewer errors. A large percentage in each category had no basis to judge.

Breakdown of Response by Category of Association

	Agree	Disagree	Does not apply	No basis to judge
	----------(percent of associations)-------			
Designers	58	18	3	21
Contractors	53	16	2	28
Labor	10	40	-	50
Manufacturers	45	29	4	23
Distributors	37	16	5	42
Codes and Standards	40	40	-	20
Real Estate	28	28	-	44

For example, use of a better system could result in architects saving time and reducing errors in the design of a building. Contractors may reduce time and labor costs in laying out a building and in job estimating.

The savings that may result are difficult to determine and are not easily documented. Any long-term benefits of metric conversion must also be reduced by the increase in calculation and estimating time and number of errors that may result while the metric system is being learned and a "feel for the system" is being developed. There would also be some costs of familiarizing personnel with the new system.

Opportunities

Many metric conversion advocates view metric conversion, in and of itself, as of little benefit to the building and construction industry, primarily because it is essentially a domestic industry. They propose that, if the industry is to get something out of going metric, it must take advantage of the opportunity to make certain additional and concurrent changes.

Although many changes in building standards and practices have taken place as a result of new technology and materials, many existing standards and practices have been in use for many years. These could be studied and evaluated to determine whether new and different practices may be more beneficial. For example, placing studs 16 inches on center is still a common practice. Some are placed 24 inches on center. In making a change to metric, the industry and Codes and Standards officials may agree on placing studs 60 centimeters (about 24 inches) on center. This new practice may save lumber and construction time. Other standards, such as the height of kitchen cabinets and counter tops and the height of doors, may be evaluated because people have been getting taller. Although opportunities exist to examine the entire spectrum of how the industry does things, those often associated with metrication of the building and construction industry are the opportunities for (1) implementing the concept of dimensional coordination, (2) standardizing and rationalizing the number of product sizes, and (3) improving building codes. All of these would relate to the process of the industry deciding on and making changes in dimensions from customary to metric.

Efforts to carry out such changes have been going on for many years and have been successful to a large extent. Whether metric conversion would provide greater success in these endeavors is not known. To successfully implement some of these would require a large, concerted effort by the industry. Sufficient resources and lead time before metric conversion would have to be available to adequately evaluate the opportunities and plan for their implementation. It should be pointed out that these opportunities have been available and would continue to be available under the customary system of measurement, and there is no assurance that these opportunities would be taken advantage of if conversion takes place.

Dimensional coordination

Metrication has been suggested as an opportune time to implement dimensional or modular coordination. Dimensional coordination is establishing a direct relationship between the dimensions of a building and the products and materials used in its construction so that they fit together with a minimum amount of cutting and adjusting. The key to the concept is that the sizes of all products and all the dimensions of the building are in certain multiples and submultiples of a basic module--a unit of length, such as 4 inches or the internationally accepted 100 millimeters--so the products will interface. For example, with a building 40 feet in length, 30 concrete blocks each 16 inches long with the mortar could be used without cutting blocks (30 by 16 inches equals 480 inches or 40 feet). In addition, sixty 8-inch-long bricks and ten 4- by 8-feet wall panels could be used without cutting. All of these dimensions are multiples of 4 inches. This pattern would be followed for windows, doors, tile, bathtubs, kitchen cabinets, etc.

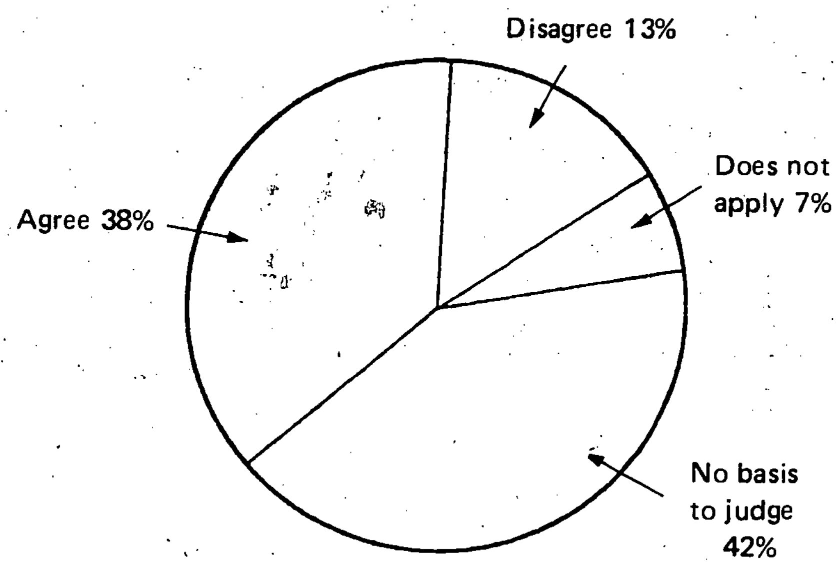
Many have suggested that metrication would not be economically justified for the industry if dimensional coordination was not adopted at the same time. The work plan of the ANMC Construction Industries Coordinating Committee states that the Committee

> "* * * endorses the concept that the major advantage to metric conversion for the Construction Industry is the catalytic effect it could have in bringing about Dimensional/Modular Coordination of Design, Products and Construction * * *."

In addition, major associations, such as the American Institute of Architects and the National Association of Homebuilders, have endorsed the concept.

The views of the associations, as provided in the responses to our questionnaire, on whether metric conversion would provide an opportunity to implement dimensional coordination are shown below. The largest response, over 40 percent, was that they had no basis to judge.

Conversion Would Provide an Opportunity To Implement Dimensional Coordination



Breakdown of Responses by Category of Association

	Agree	Disagree	Does not apply	No basis to judge
	----------(percent of associations)--------			
Designers	39	12	15	33
Contractors	44	7	9	41
Labor	44	11	-	44
Manufacturers	32	18	8	43
Distributors	42	5	-	53
Codes and Standards	60	-	-	40
Real Estate	22	11	6	61

The key segments with regard to implementing dimensional coordination--Designers, Contractors, Labor, and Manufacturers--had a greater percentage of associations that believed conversion would be an opportunity to accomplish this than

those that did not think so. However, in all cases, a substantial number did not know.

The proposed benefits of dimensional coordination are the lowered costs resulting from (1) fewer building product sizes needed in stock, (2) faster drafting of design working drawings, (3) simplicity and economy in estimating, inventory, ordering, delivery, and site storage, (4) less cutting and fitting of materials at the construction site, and (5) fewer pieces of material cut off and thrown away.

Dimensional coordination was first proposed in 1936. Despite pushes for its implementation in the 1940s, 1950s, and 1960s, the total concept has never caught on. The blame for lack of full implementation of the concept has been directed at (1) the architects for not designing in accordance with the requirements of the concept and specifying nonmodular products and (2) the manufacturers for not producing the necessary product sizes. Furthermore, any cost savings that resulted when the concept was tried were not passed on to the builder, and in some cases, modular building cost more because the necessary products had to be special orders.

Many products are available in multiples of 4 inches. Examples of these are brick and concrete block, wall paneling, gypsum board, windows, and doors. However, they may not be in multiples that would allow them to be interfaced with other products. The manufacturers of the various products independently arrived at their sizes without considering whether they would interface with the other products. An example is the standard 6 feet 8 inches door, which is a multiple of 4 inches. The opening in masonry walls also is often 6 feet 8 inches in height. The problem is that a 2-inch casing for the door is needed. Thus, a 2-inch strip has to be cut out of the masonry blocks for the door casing.

In addition, products, such as tile and kitchen cabinets, are in multiples of 3 inches. Often, nonmodular sizes are also produced. For example, there are a nonmodular eight-inch brick, which with the mortar is greater than 8 inches, and the "3-inch brick."

Architects seldom design according to the full concept of dimensional coordination. Their major priorities are to meet the clients use and space requirements. For example, a client may want an office building with 5,000 square feet of space and a certain number of offices. The architect prepares the design by working down from the 5,000 square feet. He generally is not concerned with whether the dimensions of the building will be in the necessary multiples and submultiples.

Proponents of tying dimensional coordination with metrication of the building industry believe that conversion offers an opportunity to finally succeed in implementing the concept. They indicate that product sizes, at least many of them, will have to change because of metrication; therefore, the industry can establish recommended dimensions for designing buildings and recommended sizes of products that would allow the products to fit. Use of a metric module, such as 100 millimeters rather than 4 inches, is not viewed as improving the concept. Proponents, however, believe that, without the need to change sizes created by conversion, manufacturers would be reluctant because of the cost, tradition, and fear that the marketplace would not accept the new sizes.

Whether the industry would take any opportunity offered by metric conversion to implement dimensional coordination is unknown. Some products probably would be coordinated, but it is not certain whether this would occur to any greater degree than what exists or may occur under the customary system. Implementation has been attempted several times since the concept was developed in 1936 without success. A large number of associations indicated that they had no basis to judge whether conversion would provide the opportunity.

The industry's acceptance of the concept as a part of metrication would depend not only on how the industry views metrication to be an appropriate time for its implementation. In any event, a concerted effort would be needed by the various facets of the industry to plan for and implement the concept of dimensional coordination. A national program would probably be needed.

Standardization and rationalization of products

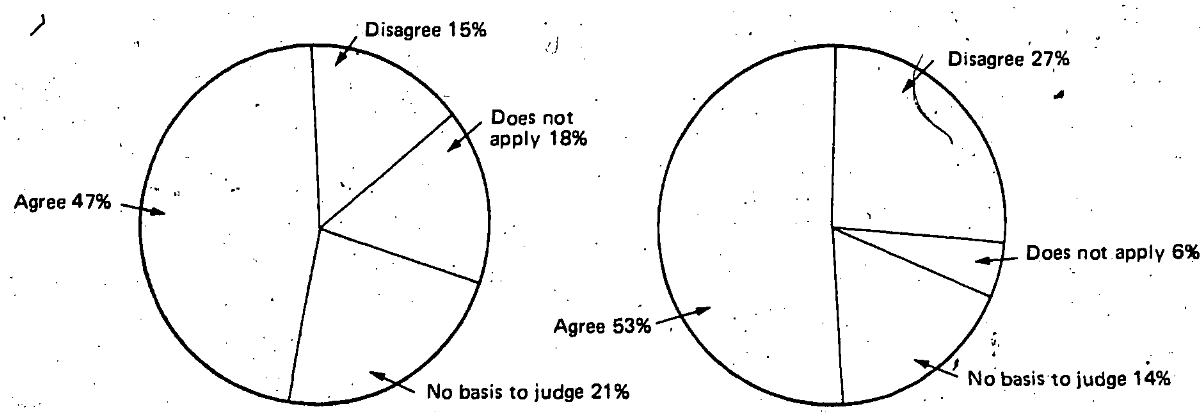
A major proposed advantage of metrication is the opportunity to standardize and rationalize products. Standardization and rationalization would probably occur to a large degree under a program of dimensional coordination, but it can take place in the absence of such a program.

During hard conversion of products, the actual sizes would change. In deciding what the new metric sizes should be, the industry may agree on certain sizes for manufacturers to produce. This would be standardization. Rationalization would be agreeing to a limited set of sizes in a rational or preferred series. Eventually all sizes not in the series would be eliminated. This generally would result in a reduced number of sizes.

Product standardization and rationalization may simplify, to an extent, the work of the architect, contractor, and distributor. It may also reduce the cost of certain products because of longer production runs and reduce inventory costs for the manufacturers, distributors, and contractors. In addition, the chance for ordering, delivering, or using the wrong size of a product may be reduced.

The opportunity exists for many building products to be standardized and rationalized because several sizes are produced. As shown in the following responses to our questionnaires, substantially more of the associations and small construction firms agreed than disagreed that conversion would provide an opportunity for standardization.

Standardization of Products



Response by Category of Association

	Agree	Disagree	Does not apply	No basis to judge
	----------(percent of associations)----------			
Designers	55	6	18	21
Contractors	48	13	17	22
Labor	44	-	11	44
Manufacturers	41	22	19	19
Distributors	79	-	-	21
Codes and Standards	20	20	20	40
Real Estate	61	11	17	11

The Distributors sector had the largest percentage of associations that believed conversion would provide an opportunity for product standardization.

The sizes of building products generally have developed in the marketplace over the years to fit the industry's needs. In addition, product sizes are often a means of competition between manufacturers. All product sizes are generally not produced by all manufacturers. For these reasons, manufacturers of some products, such as brick, block, and panel, believed there was not much potential for standardization and rationalization.

One building product frequently mentioned as having large potential for standardization and rationalization is windows. Reportedly, window sizes in the United Kingdom were reduced from 1,600-inch sizes to 200-metric sizes. In Canada, the 961-inch sizes are to be reduced to 267-metric sizes after conversion.

In addition to being functional, windows are often a means of architectural expression. The result has been a demand for windows of many different materials, sizes, styles, and features. The U.S. window industry has made available a wide range of window sizes and styles to meet these demands. Thus, the potential for standardization and rationalization of windows exists not only for sizes but also for styles.

The proliferation of style has also occurred in other products, such as doors and concrete blocks. Block sizes, for instance, are standard and not a great number are produced. However, there are from 2,000 to 3,000 different block styles.

In summary, the potential for rationalization and standardization exists for many products, not only in sizes but in styles. Realizing this potential may be difficult because it would require that architects and their clients restrict their demands for different sizes and styles and that manufacturers not use size and style as a means of competition. If standardization and rationalization were to come about, there would be no assurances that the demand for custom or special-order products would not increase.

BUILDING CODES: A METRICATION COST OR BENEFIT?

The case of building codes offers an interesting look at the advantages and disadvantages of metrication for the

building and construction industry and the dilemma that metrication poses. On the one hand, metricating the codes could be a large and costly process. Changes in the codes could also require costly retesting of building products.

On the other hand, metrication proponents believe that this process offers an excellent opportunity to make substantial improvements in the codes which would not be made without metrication. Proponents generally view code improvements as a major advantage of metrication.

However, if metrication occurs, some costs are certain, but the benefits are not assured. There are no assurances that the opportunity to improve the codes would be taken or that the improvements would not be achieved under the customary system.

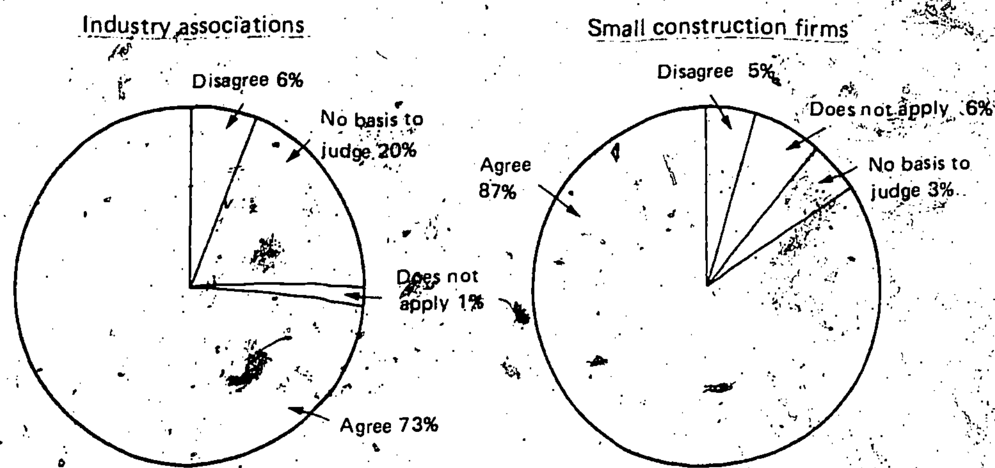
A building code is a series of standards and specifications designed to (1) establish minimum safeguards in the erection and construction of buildings, (2) protect occupants from fire and other hazards, and (3) protect public health and safety. Building codes are formulated and enforced through State governments, often delegated to and exercised by local governments. An estimated 12,000 jurisdictions administer building codes. In the building construction field, four major organizations promulgate model building codes for use by State and local government building regulatory officials. The State and local governments often follow one of these model codes but retain the authority to reject or alter the provisions. In addition to the model codes, there are mechanical codes; such as for plumbing, elevators, and electricity; and special codes usually promulgated by States for theaters, hospitals, schools, nursing homes, etc.

Building codes usually include the types of construction, function of the structure, quality of materials, imposed loads, allowable stresses, mechanical and electrical equipment, and other requirements with special emphasis on fire safety. These requirements are usually expressed in customary weights and measures, as are the corresponding standards. Metrication of the building and construction industry would require that these references be changed to metric.

Building codes as a metrication cost

A large percentage of the associations and the small construction firms responding to our questionnaires believed that a significant disadvantage of metric conversion would be the need to change building codes.

Building Codes Would Have to be Changed



How the codes are converted to metric would probably depend on the decisions made by the building and construction industry and the model code groups, standards-writing organizations, and code regulatory officials. Code conversion would probably be a combination of soft and hard. In any event, it would appear to be a major task. We were told by the director of a key code organization that metrication of building codes would be tremendously costly. It would require a large rewrite effort and education program for code and building officials. Every code would have to be reviewed. The review and rewrite could not be done as part of the normal code review process.

Retesting of building products

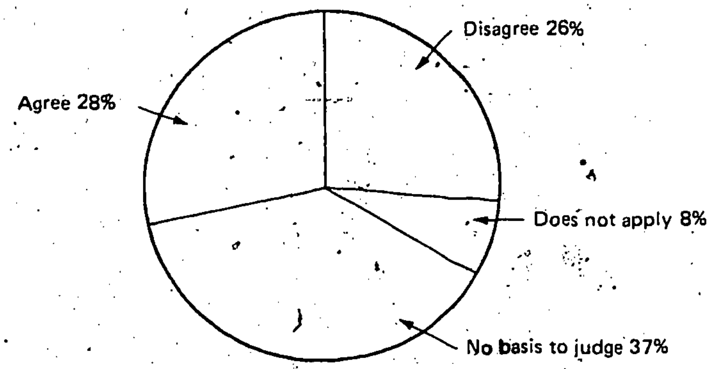
Hard conversion of building products may change their properties enough that they no longer meet the established standards on which the codes are generally based. To determine whether the metric product does meet the standards, the product may have to be retested. The industry has millions of dollars invested in these tests, and retesting would be expensive. For example, we were told by an industry official that retesting of wall assemblies for fire safety alone may cost about $2,000 for each of the 50 different types.

The impact would depend on what new dimensions are selected for products. The new product sizes may be within the tolerances allowed in the standards or may exceed the standards and thus present no problem. The thickness is the key dimension for many products, such as wood paneling and gypsum board. Although the outer metric dimensions of these products have tentatively been agreed on, decisions on thickness have not been made. If the thickness is increased, the standards may not be a problem. However, more material would

mean higher costs, possibly without any real improvement in the product.

The questionnaire responses from the associations (similar information was not obtained from the small construction firms) was indecisive. A large portion did not know whether building products would need retesting.

Building Products Would Need Retesting

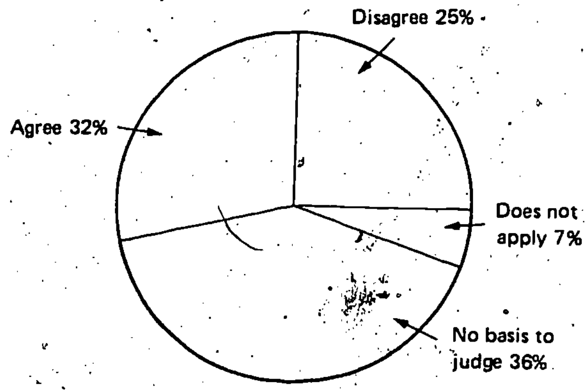


Building codes as a metrication benefit

Metrication proponents believe that the process of metricating building codes is an opportune time to make code improvements becase they would have to be reviewed provision by provision to identify and replace customary references with metric. It has been proposed that during this review process, code officials could eliminate differences in the codes and allow for new building technology and materials that have not yet been accepted in the codes. The need for these improvements have been pointed out over the years by the industry and various study groups.

The chart on the following page indicates the views of the associations on whether metric conversion would provide an opportunity to improve building codes. The largest percentage had no basis on which to give an opinion.

Conversion Would Provide an Opportunity to Improve Building Codes



Response Breakdown by Category of Association

	Agree	Disagree	Does not apply	No basis to judge
	----------(percent of associations)--------			
Designers	31	28	13	28
Contractors	34	21	2	43
Labor	33	11	-	56
Manufacturers	25	32	10	34
Distributors	42	16	-	42
Codes and Standards	60	-	-	40
Real Estate	17	22	6	56

Improving building codes has been a major goal of the industry, model code groups, and building regulatory officials for many years. Substantial improvements have been achieved, and these efforts are expected to continue.

The model codes are becoming harmonious. The model code groups have jointly issued a "One and Two Family Dwelling Code." Other efforts to increase uniformity include formation of (1) the Model Codes Standardization Council to develop uniform language and standards, (2) the National Research Board to test and evaluate new products seeking acceptance by the model code groups, and (3) the Board for Coordination of the Model Codes to coordinate the work of the model code groups. Recently, the three major model building code organizations announced that they are considering a merger. A consultant was to be engaged to study the feasibility of merging.

The States also have been active in improving building codes. In 1965 only five States had adopted legislation providing for the promulgation of mandatory statewide building codes applicable to construction, with some exceptions. Latest available data indicates that 19 States have statewide building codes that set at least minimum requirements for construction, with some exceptions. Much of the credit for this effort has been given to the National Conference of States on Building Codes and Standards. The National Conference is made up of State and local building regulatory officials. In addition to serving as a forum for discussion, the Conference also assists in the development of programs leading to the adoption of uniform comprehensive building codes and standards and to development of standard and code practices that will encourage the introduction and uniform recognition of innovation in building materials.

In addition, the National Institute of Building Sciences was established by Section 809 of the Housing and Community Development Act of 1974 (Public Law 93-383) as a nongovernment and nonprofit organization. The mission of the Institute is to improve building and encourage more effective use of building resources by stimulating development of needed scientific and technical knowledge and ensuring that worthwhile construction technologies are rapidly introduced to and accepted by the building community. At the time of our study, the Institute members had been appointed and were organizing.

Thus, much effort has been directed toward improving building codes. This effort is expected to continue. It is unknown whether metrication would give further impetus to improving and giving greater uniformity to the codes or whether the process of metricating the codes would be primarily an administrative task. However, if metrication of the building and construction industry is considered advantageous or necessary, an effort should be made to at least maintain the present amount of code uniformity by having any changes resulting from metrication accepted uniformly by the model code groups and the State and local jurisdictions to the extent practical. These efforts should be in concert with the plans of the industry. Any development of industry conversion plans and timetables should include appropriate code officials.

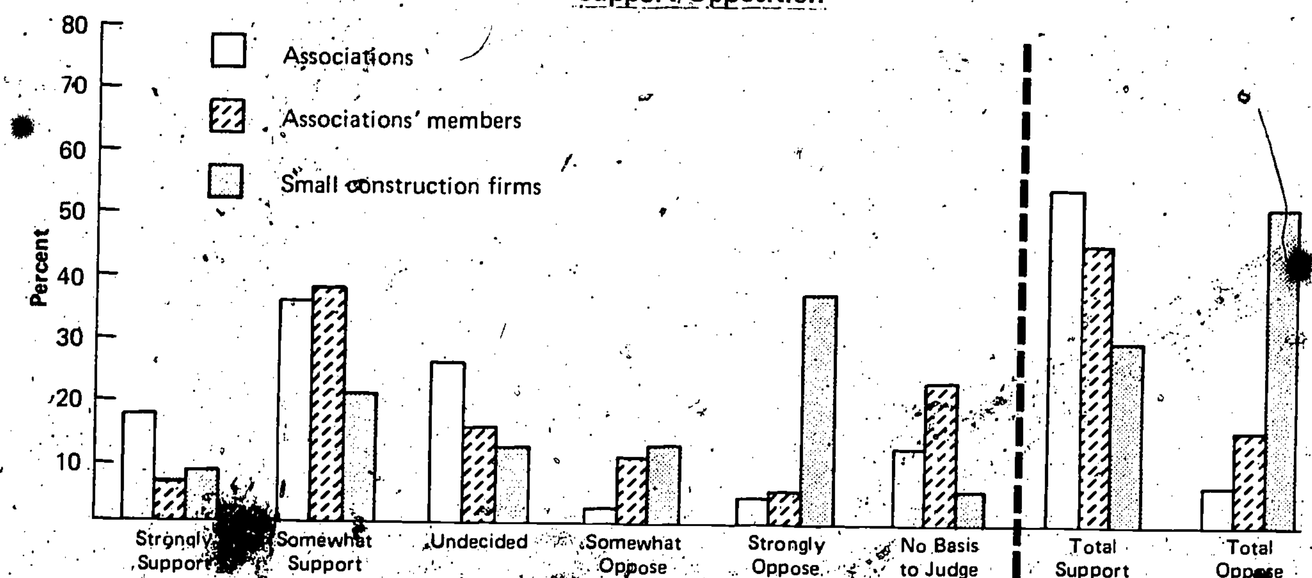
INDUSTRY VIEWS ARE DIVIDED ON THE OVERALL QUESTION OF METRICATION

In our questionnaires we asked about metrication support/opposition, inevitability, advantages/disadvantages, and effect on prices. The responses varied but indicated that the associations tended to believe in metrication and thought their membership did also but to a lesser degree. There was, however, a marked contrast in the views of the small construction firms,

Inconclusive support/opposition for conversion

The associations supported conversion [illegible]7 percent, and they thought that about 45 percent of [illegible] members supported conversion while about 16 percent opposed. Support for converting changes to opposition when the results of the small construction firms are examined. About 51 percent opposed conversion while only about 30 percent supported it. It is important to note that 39, 37, and 19 percent of the respective respondents were either undecided or had no basis to judge. (The associations' members were not polled on their opinion, but we asked association officials their views on what the opinions of their members were.)

Support/Opposition



Most associations in each sector of the industry supported conversion than opposed it. The Designers and Codes and Standards sectors were the most supportive. The least support was in the Labor, Distributors, and Real Estate sectors.

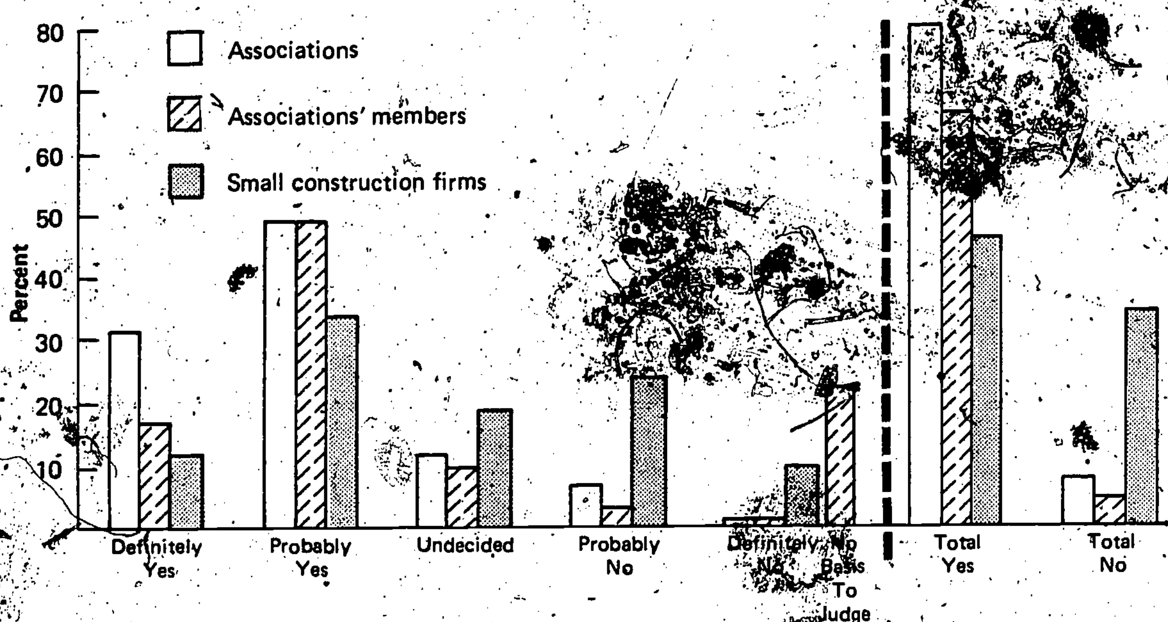
Breakdown of Response by Category of Association

	Support	Oppose	Undecided	No basis to judge
	------(percent of associations)-----			
Designers	70	9	9	12
Contractors	54	4	19	23
Labor	10	10	50	30
Manufacturers	55	9	29	8
Distributors	47	11	26	16
Real Estate	33	11	39	17

Inevitability of conversion

The following graph shows that a large part of the building and construction industry believed that conversion is inevitable. Eighty percent of the associations and about 46 percent of the small construction firms felt this way. About 66 percent of the associations thought that their members also considered conversion to be inevitable.

Views on Inevitability



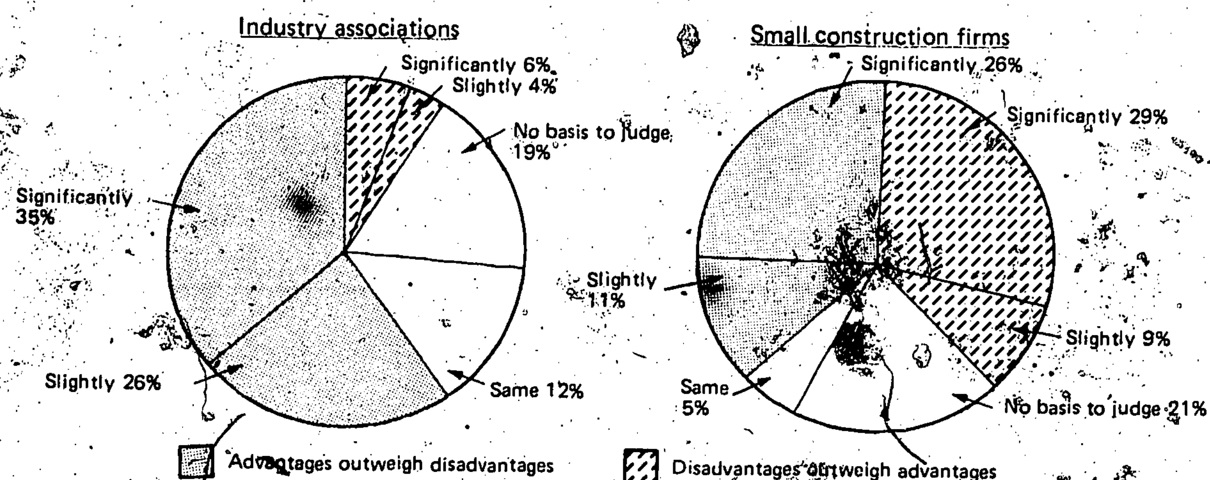
During our discussions with industry representatives, we were often told that conversion of the building and

construction industry is inevitable because other industries are converting or will convert and the "ripple effect" will eventually force the industry's suppliers and the industry itself to convert. Some thought that the Federal Government would force conversion, that the Metric Conversion Act was the initial step and further Federal legislation or action is anticipated. About 31 percent of the associations and about 42 percent of the small construction firms thought that conversion was mandatory. The Metric Conversion Act, however, provides for voluntary conversion.

Advantages/disadvantages

In our questionnaire we asked the associations their opinions on how the advantages and disadvantages of metric conversion for the United States, as a whole, and for their members would compare. We asked similar questions of the small construction firms.

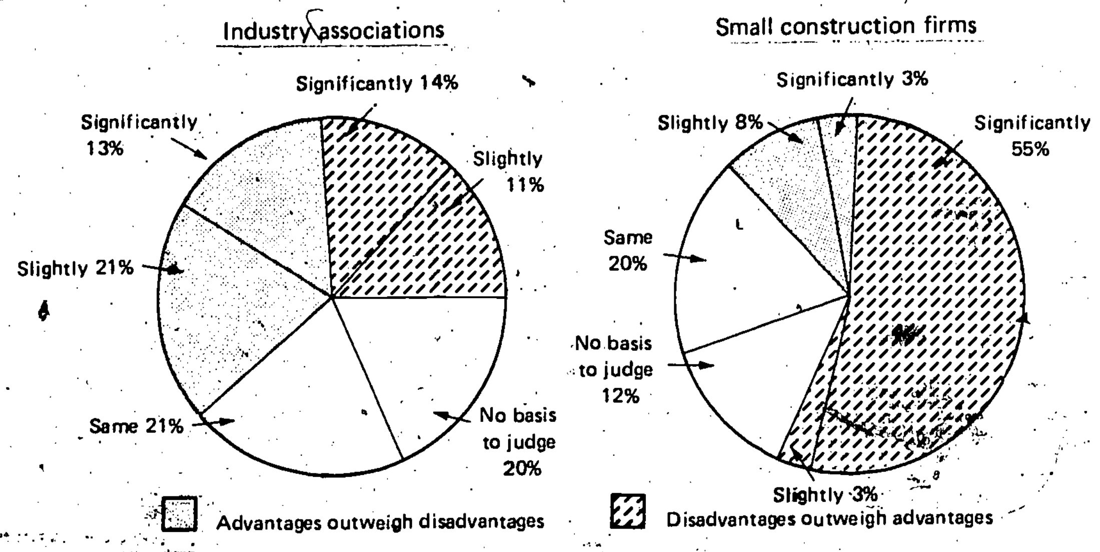
Advantages Versus Disadvantages for the United States



About 61 percent of the associations thought that the advantages would outweigh the disadvantages. A greater percentage of the small construction firms, however, thought the disadvantages for the United States would be greater, but the margin was small, 38 as compared to 37 percent.

Both the associations and the small construction firms considered metric conversion to be more advantageous for the United States as a whole than for the building and construction industry.

Advantages Versus Disadvantages for the Industry



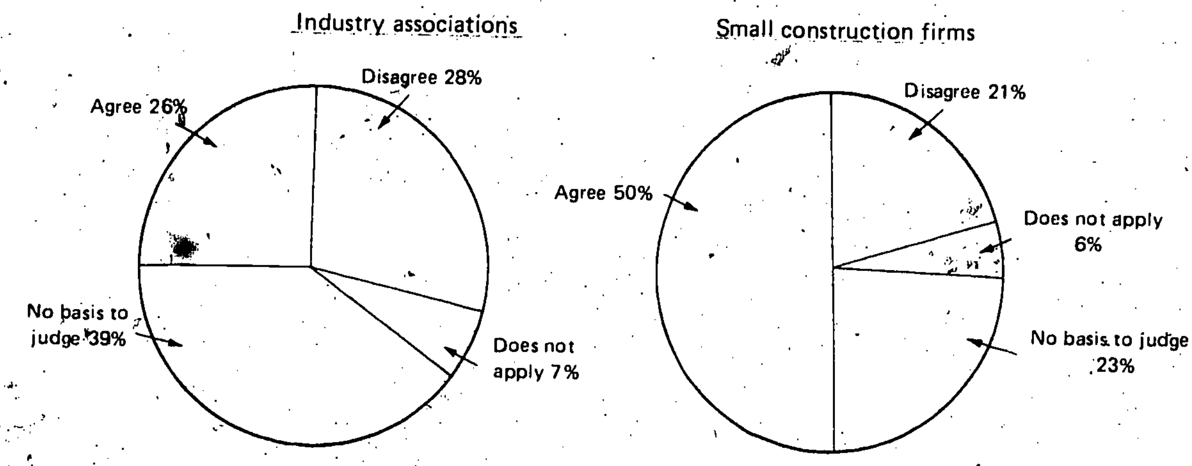
Thus, 34 percent of the associations and about 11 percent of the small construction firms thought that the advantages for the industry would outweigh the disadvantages. About 25 percent of the associations and about 58 percent of the small construction firms believed that the disadvantages would be greater.

A greater percentage of the associations representing the Designers, Contractors, and Codes and Standards sectors thought that conversion would be advantageous. More of the Labor, Distributors, and Real Estate sectors considered the disadvantages to be greater. The manufacturers were evenly divided.

	Advantages greater	Disadvantages greater	About the same	No basis to judge
	(percent of associations)			
Designers	42	15	27	15
Contractors	52	11	19	19
Labor	10	40	10	40
Manufacturers	31	31	22	17
Distributors	18	41	12	29
Codes and Standards	40	20	20	20
Real Estate	11	39	17	33

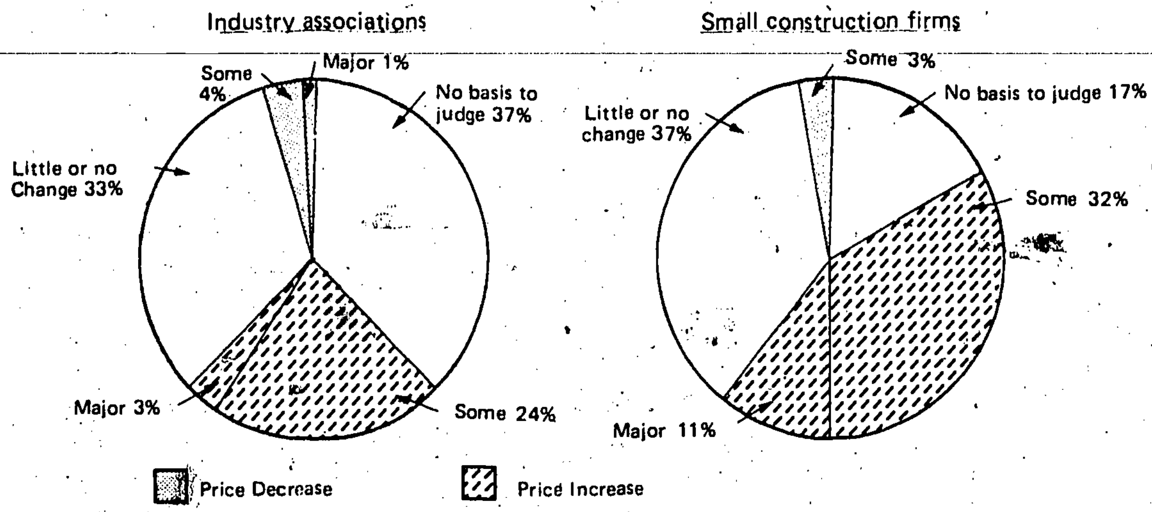
The anticipated impact of metric conversion on prices of products and services should be a reflection of how conversion costs and benefits are viewed. The associations and small construction firms responded as follows as to whether metric conversion would increase prices.

Conversion Would Increase Prices



In addition, we asked what the long-term impact of metrication on prices would be. About 33 percent of the associations and 37 percent of the small construction firms anticipated little or no change. About 43 percent of the small construction firms and 27 percent of the associations expected an increase. Only about 5 percent of the associations and 3 percent of the small construction firms thought conversion would decrease prices. It should be noted that 37 percent of the associations and 17 percent of the small construction firms indicated that they had no basis to judge the impact.

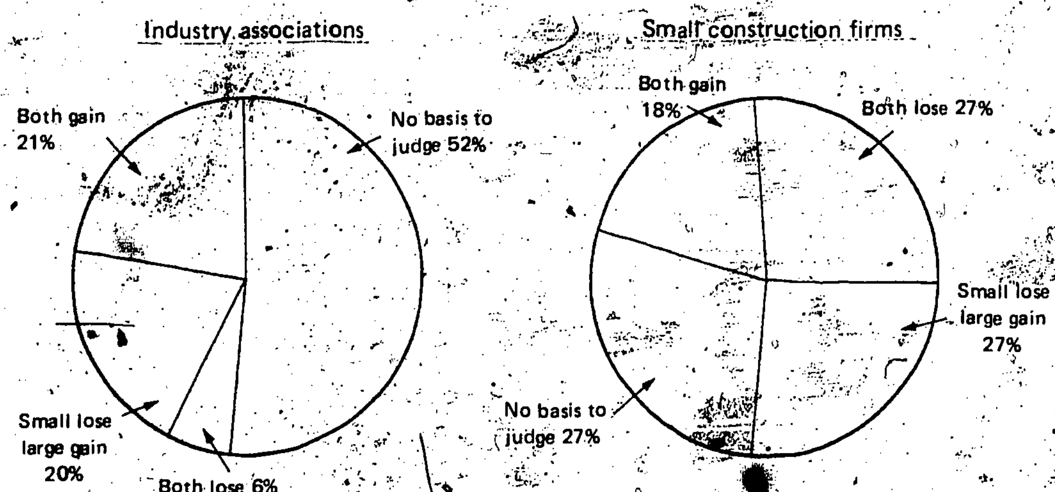
Long-term Impact on Prices



Only a small part of the industry anticipated a decrease in prices. This would appear to mean that the benefits of conversion would not result in actual cost savings for the industry or that the cost savings would not be passed on to customers.

Who would gain or lose--small or large firms--from metric conversion? As shown in the following charts, about 52 percent of the associations and 27 percent of the small construction firms had no basis to judge. Of those that had an opinion, the associations were more positive toward conversion.

Who Gains or Loses from Conversion— Large or Small Business



PROPOSALS TO BRING ABOUT CONVERSION

Several methods that involve a greater role for the Federal Government have been proposed by some in the industry to effectively reduce the industry's passiveness toward metric conversion. The proposals are that the

--Federal Government mandate conversion,

--Federal construction agencies use their significant purchasing power to "prod" the industry into converting, and

--U.S. Metric Board, in conjunction with the industry, establish a time frame for converting.

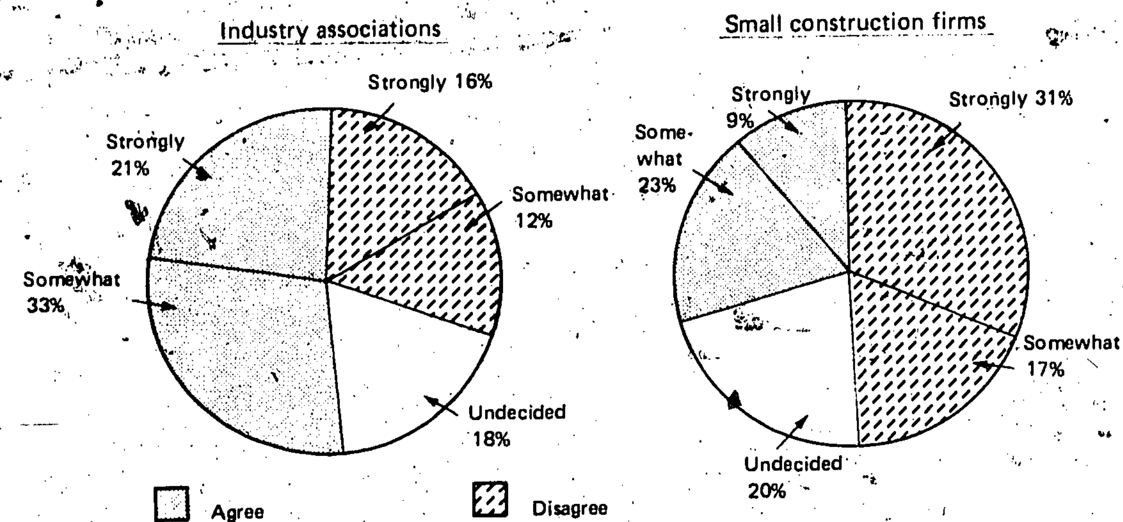
Mandatory conversion

The building and construction industry probably would not convert to the metric system in the near future without a national policy to convert and greater participation by the Federal Government. The most effective means of bringing about full conversion of the industry would probably be mandatory conversion. This method, however, is generally opposed. Only 19 percent of the associations and 16 percent of the small construction firms thought that the Federal Government should make conversion mandatory.

Use of Government purchasing power

Our questionnaire results showed that 54 percent of the associations and 32 percent of the small construction firms agreed that the Federal Government should encourage metric conversion by purchasing items designed or described in metric terms. About 28 percent of the associations and about 48 percent of the small construction firms disagreed.

Use of Federal Purchasing Power to Encourage Conversion



As shown earlier, the Federal construction agencies generally did not believe that their purchasing power should be used to prod the industry into converting. They believed that their agencies should keep pace with, but not lead, the industry. Several officials indicated that their agencies did not have a large enough share of the construction market to force the industry into converting.

Whether specifying that Federal construction projects be performed in metric would force the industry to convert is open to question, but proponents of this method believe that it would create a market for metric products and provide financial support to the industry in its conversion efforts. If a Federal construction agency specified, for example, a metric-size concrete block to be used in a building, the Federal Government would probably pay for the necessary new metric molds and equipment adjustments through a higher price for the block. Adding metric equivalents to specifications without any change in dimensions or product sizes would not involve these costs but probably would be less effective in forcing the industry to convert.

The purchasing power of the Government construction agencies was used in both Australia and Canada even though conversion was considered to be voluntary. This was done by specifying that Government construction projects be designed and built in metric dimensions. An Australian official gave this method credit for a quick and effective conversion of the Australian industry.

In Canada the construction agencies of federal, provincial, and territorial governments, which account for about 40 percent of total construction dollars, have committed themselves to be among the first to design and construct in metric terms. This provides an assured market for metric products. The objective is to have as many new projects as possible in metric after January 1, 1978, the start of metrication of the construction idustry. For example, the Canadian Department of Public Works plans to develop all design drawings and specifications in metric for all new building construction to be procured in 1978. The construction agencies are expected to spend between $5 billion and $6 billion (Canadian) on metric contracts during the 1978-79 fiscal year.

During the initial stages of the Australian conversion program, designers were reluctant to specify in metric terms until they knew whether metric products would be available and when. Manufacturers were unwilling to produce in metric sizes until there was a realistic demand for the new product sizes. To overcome this, government agencies began using metric design for construction as much and as soon as possible. Although metric products were not always readily available, this gave the manufacturers assurances that there would be an ongoing demand for their products. By agreement, the individual states established a specific cut-off date after which local governments were not permitted to accept for approval construction plans and specifications unless they were in metric terms.

Conversion target dates

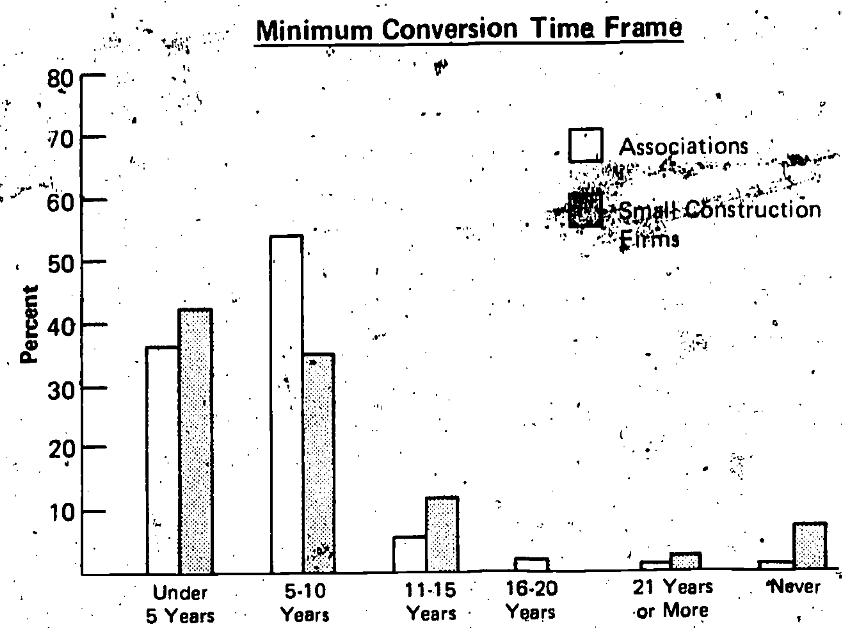
The third proposal is for the U.S. Metric Board, in consultation with the industry, to establish a conversion target date or time frame for the industry to convert. This would address the need for a coordinated, industrywide effort. This time frame, to be effective, may have to be given the added weight of an executive order or legislation.

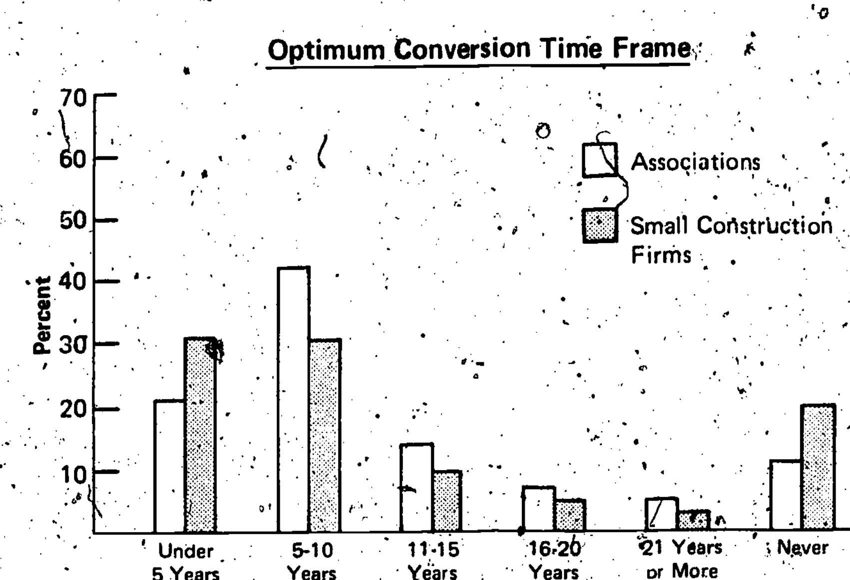
A conversion time frame appears essential for each of the three proposed methods. The time frame is needed for the industry to properly plan and coordinate. Architects would know when metric products are available, and manufacturers would know when to produce metric products.

Many factors should be considered in establishing a time frame. For example, some may want a time frame as short as practicable because of the dual inventories problem. Others may believe a longer time frame is necessary. The guiding principle should be to maximize benefits and minimize costs. More than one target date may be established for the

industry with the time frame of one segment differing from, but coordinated with, that of another.

About 90 percent of the associations and 77 percent of the small construction firms said that they could convert in 10 years or less. Sixty-three percent of the associations and 62 percent of the small construction firms thought that 10 years or less would be the optimum time frame for conversion; i.e., conversion could be most favorably implemented in 10 years or less.





The industry was split over who should establish the target dates for conversion. The U.S. Metric Board (in consultation with the industry) was the most popular single choice for the associations (39 percent). The largest percentage (36 percent) of the small construction firms believed the industry should establish the dates.

Who should establish conversion dates	Associations	Small construction firms
	---------(percent)---------	
The Congress	14	16
U.S. Metric Board in consultation with the industry	39	29
Industry (associations and/or individual firms)	33	36
Other	4	2
No basis to judge	10	17

CONCLUSIONS

The building and construction industry is moving very slowly in metrication. A large number of the associations and small construction firms that responded to our questionnaires indicated they were not involved in metrication and had no plans to become involved. Much of the industry is passive toward metrication.

One of the major reasons for lack of metrication activity in the industry is that the industry presently has no compelling need to convert because

--it is primarily domestic, and the measurement system was generally not considered a significant factor in exports;

--it has no difficulty obtaining customary materials;

--its customers are not demanding construction in metric; and

--conversion is voluntary, there is no legal requirement to convert.

Another major reason is that it is difficult for individual firms or segments of the industry to act alone. The industry is large, diversified, and fragmented but also highly

interdependent. Many products and services must come together in the final product. No firm is large enough to act as an industry leader.

Much of the industry is also concerned about metrication costs and not certain of the benefits. Although the impact would vary, almost every firm and segment of the industry would bear some conversion costs. Costs are unknown but would be involved in converting production equipment, training personnel in metric, keeping dual inventories, metricating building codes, possible retesting of building products, and losing time and efficiency while adapting to a new measurement system. Concerns have also been expressed that metrication would cause customer confusion.

Metrication benefits are uncertain. The industry is divided over whether the metric system is easier to use and would result in fewer errors, and the major proposed advantages are actually opportunities. Metric conversion advocates believe that if the industry is to get something out of converting to metric, it must take advantage of what they consider the inevitable change by evaluating and making certain additional and concurrent changes in building and construction practices. Although opportunities would exist, as they presently do, to examine the entire spectrum of how the industry does things, those often associated with or tied to metrication are the opportunities to (1) implement the concept of dimensional coordination, (2) standardize and rationalize the number of product sizes, and (3) improve building codes.

Efforts to carry out such changes have been going on for many years under the customary system and have been successful to a large extent. Whether metrication would provide greater success in these endeavors is not known. The act of converting would not alone accomplish these objectives but it would provide a further opportunity to do so.

To successfully implement these changes would require a large, concerted effort by the industry and sufficient resources and lead time to adequately evaluate the opportunities and plan for their implementation. There are no assurances that such an effort would be made or that the same objectives could not be accomplished under the customary system.

The case of building codes offers an interesting look at the advantages and disadvantages for the industry and the dilemma that metrication poses. On the one hand, metricating the codes could be a large and costly process. Changes in the codes could also mean that some building products may have to be retested.

On the other hand, proponents of metrication believe that the process of metricating the codes offers an excellent opportunity to make substantial improvements by increasing uniformity and accepting new technology and products into the codes. However, this is only an opportunity. Thus, some costs are certain, but the benefits are not assured.

Although much of the industry considers metric conversion to be inevitable, it probably will not convert, at least in the near future, unless it is mandated or the Federal Government establishes a clear national policy to convert and plays a greater role in the conversion. Apparently, this is due primarily to the industry having no compelling reasons, having no one to take the lead, and being uncertain of the costs and benefits.

Several methods have been proposed by metrication proponents to bring about conversion of the industry. The major proposals are:

--The Federal Government should mandate conversion, at least for this industry.

--The Federal agencies should use their purchasing power to prod the industry into converting.

--The U.S. Metric Board, in conjunction with the industry, should establish a time frame for conversion.

All of these involve a greater role for the Federal Government.

Mandatory conversion is generally opposed by the industry. Use of Federal purchasing power has some support in the industry. However, Federal construction agencies generally thought that they should keep pace with, but not lead, the industry. Several of the Federal officials believed that their agencies were not large enough in the building and construction market to have an impact. In total, the Federal Government has only about 5 percent of the construction market.

If the Nation and the industry make a commitment to convert, the establishment of a target date(s) would be needed to coordinate a conversion program for such a large and diversified but interdependent collection of industries. Such a conversion program should include a consideration of appropriate and worthwhile opportunities. The target dates should allow sufficient time to identify and plan for the implementation of these opportunities.

U.S. GENERAL ACCOUNTING OFFICE

METRIC TASK FORCE

SURVEY OF THE BUILDING AND CONSTRUCTION INDUSTRY

INSTRUCTIONS:

Please answer each of the following questions as frankly and completely as possible.

We are interested in your views, whether or not you consider yourself to be as knowledgeable about our questions as you would like to be. Answers on your members' views need not be based on formal surveys of their opinions.

We have made the following assumptions so that all respondents will have a common basis for answering:

-- Conversion means physical changes, not just substituting metric measurement units for English or customary measurement units (inch, pound, quart, etc.)
-- Conversion does not apply to items already produced or in production.
-- During the conversion, metric supplies and services will be readily available.

There is space at the end of the questionnaire for any comments you may wish to make concerning these assumptions, the questionnaire, or any other related topics.

The questionnaire is numbered only to permit us to delete your name from our list when we receive your completed questionnaire and thus avoid sending you an unnecessary followup request.

Throughout this questionnaire there are numbers printed within parentheses to assist our keypunchers in coding responses for computer analysis. Please disregard these numbers.

RESPONDENT INFORMATION:

NAME: ______________________

TITLE: ______________________

TELEPHONE: ( ) ______________________
(Area code) (Number)

A. Association's Purpose and Membership

1. Which of the following are primary functions of your association? (Please check all that apply.)

1 /_/ Formulate professional standards (6)

2 /_/ Formulate technical standards (7)

3 /_/ Provide technical data (8)

4 /_/ Lobby for members (at local, State, or Federal level) (9)

5 /_/ Serve as a professional forum (10)

6 /_/ Review proposed legislation and standards (11)

7 /_/ Inform members of proposed legislation and standards (12)

8 /_/ Provide training seminars to members (13)

9 /_/ Promote member products or services (14)

10 /_/ Other (Please specify) ________ (15-16)

APPENDIX I

2. Approximately how many a) full members, and b) associate/affiliate members currently belong to your association? (Please check one for a and one for b.)

a) Full members		b) Associate/affiliate members	
1 /_7 Less than 100	(17)	1 /_7 0	(18)
2 /_7 100 - 1,000		2 /_7 1 - 100	
3 /_7 1,001 - 10,000		3 /_7 101 - 2,000	
4 /_7 10,001 - 25,000		4 /_7 2,001 - 5,000	
5 /_7 25,001 - 50,000		5 /_7 5,001 - 10,000	
6 /_7 More than 50,000		6 /_7 More than 10,000	

3. Generally, to which of the following categories would you assign the majority of your full members? (Please check one.)

1 /_7 Designers (architects and engineers) (19)

2 /_7 Contractors

3 /_7 Labor

4 /_7 Manufacturers

5 /_7 Distributors (wholesalers and retailers)

6 /_7 Codes and standards

7 /_7 Real estate

8 /_7 Other (Please specify)________________

____

B. Federal/State Laws and Policies

4. What is your understanding of the national policy concerning converting to the metric system? (Please check one.)

1 /_7 No stated national policy (20)

2 /_7 Mandatory conversion within 10 years

3 /_7 Federal coordination and planning of voluntary conversion

4 /_7 A mandatory, gradual conversion (i.e., more than 10 years)

5 /_7 No conversion

6 /_7 Don't know

7 /_7 Other (Please specify) ________________

____

5. Which of the following laws or regulations make it difficult for your members to convert to the metric system? (Please check all that apply.)

1 /_7 Federal antitrust laws (21)

2 /_7 Other Federal laws (22)

3 /_7 State and local laws (23)

4 /_7 Building codes (24)

5 /_7 Federal or State procurement regulations (25)

6 /_7 Other (Please specify) ______ (26)

____

7 /_7 None of the above (27)

8 /_7 No basis to judge (28)

6. If metric conversion occurs, which of the following roles, if any, should the Federal Government assume? (Please check all that apply.)

1 /_7 Plan the overall conversion (29)

2 /_7 Coordinate activities (30)

3 /_7 Establish target dates (31)

4 /_7 Counsel and advise interested parties (32)

5 /_7 Legislate the conversion process (33)

6 /_7 Make conversion mandatory (34)

7 /_7 Enforce the conversion process (35)

8 /_7 Other (Please specify) ______ (36)

____

9 /_7 None of the above (37)

10 /_7 No basis to judge (38-39)

APPENDIX I

7. Do you agree or disagree that the Federal Government should encourage conversion to the metric system by purchasing items designed or described in metric terms? (Please check one.)

1 /_/ Strongly agree (40)

2 /_/ Agree somewhat

3 /_/ Undecided

4 /_/ Disagree somewhat

5 /_/ Strongly disagree

C. Support or Opposition to Metric Conversion

8. Does your association support or oppose the United States' converting to the metric system? (Please check one.)

1 /_/ Strongly support (41)

2 /_/ Somewhat support

3 /_/ Undecided (the association)

4 /_/ Somewhat oppose

5 /_/ Strongly oppose

6 /_/ No basis to judge (you)

9. In your view, do the majority of your members support or oppose conversion to the metric system? (Please check one.)

1 /_/ They strongly support (42)

2 /_/ They somewhat support

3 /_/ They are undecided

4 /_/ They somewhat oppose

5 /_/ They strongly oppose

6 /_/ I have no basis to judge their opinions

10. Do you believe that conversion to the metric system is inevitable for the building and construction industry? (Please check one.)

1 /_/ Definitely yes (43)

2 /_/ Probably yes

3 /_/ Undecided

4 /_/ Probably no

5 /_/ Definitely no

11. In your view, do the majority of your members believe that conversion to the metric system is inevitable for the building and construction industry? (Please check one.)

1 /_/ Definitely inevitable (44)

2 /_/ Probably inevitable

3 /_/ They are undecided

4 /_/ Probably not inevitable

5 /_/ Definitely not inevitable

6 /_/ I have no basis to judge their opinions

D. Status of Metrication

12. What is the current status of each of the following metric conversion activities in your association? (Please check one box for each row.)

STATUS

ACTIVITIES	1 No Plans for	2 Plans for	3 In Process	4 Completed	5 Does not apply	6 No basis to judge	
a. Metric policy statement							(45)
b. Metric coordinator or committee							(46)
c. Member survey							(47)
d. Cost analysis							(48)
e. Member training							(49)
f. Industry standards and technical publications issued in both customary (English) and metric equivalents							(50)
g. Soft conversion1/ of industry standards and technical publications to metric units only							(51)
h. Hard conversion2/ of industry standards and technical publications to metric units only							(52)
i. Consumer information							(53)
j. Decisions on design, dimensions, or product sizes							(54)
k. Association funds budgeted for metric conversion activities							(55)
l. Timetable for conversion							(56)
m. Coordination with industry							(57)
n. Coordination with government							(58)

13. In your view, how does the metrication status of your members compare with that of your association?

1 /_/ Membership significantly ahead (59)
2 /_/ Membership slightly ahead
3 /_/ Membership about the same
4 /_/ Membership slightly behind
5 /_/ Membership significantly behind
6 /_/ No basis to judge

E. Potential Impacts of Metric Conversion

14. Listed below are several ADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant advantage for YOUR MEMBERS. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED ADVANTAGES	1 Agree	2 Disagree	3 Does not apply	4 No basis to judge	
a. The metric system is easier to use and would result in fewer errors					(60)
b. Conversion will increase or protect the present amount of export and/or work overseas of your members					(61)
c. Conversion will provide an opportunity to standardize products					(62)
d. Trade will be facilitated through a common measurement language					(63)
e. Use of the metric system will increase production efficiencies					(64)
f. Use of the metric system will facilitate technological advances					(65)
g. Conversion will provide an opportunity for improving building codes and standards					(66)
h. Conversion will provide an opportunity for implementing or expanding "dimensional or modular coordination"3/					(67)
i. Conversion will stimulate your industry					(68)

1/ English or customary units replaced with equivalent metric units without any physical changes in the size or weight of the product, material, or structure being produced. For example, the width of an item expressed in customary units as 3 feet would be expressed as 914.4 millimeters under a soft conversion with no change in the actual width.

2/ The weight or dimensions of the product, material, or structure changed, in footnote 1, primarily for the sake of simplicity. In the example above, the item with a width of 3 feet (914.4 millimeters) might be manufactured with a width of perhaps 900 millimeters (2.998 feet), a slight reduction, or 1,000 millimeters (3.281 feet), about 3½ inches wider.

3/ A direct relationship between the dimensions selected for the design of a building and the sizes of componants used in its construction. Product sizes and dimensions are based on agreed-upon rules that permit a better fit of products during the building process. Dimensions and sizes are based upon a module, such as 4 inches or 100 millimeters.

APPENDIX I

15. Listed below are several DISADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant disadvantage for YOUR MEMBERS. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED DISADVANTAGES	1 Agree	2 Disagree	3 Does not apply	4 No basis to judge	
a. Conversion will be costly					(69)
b. Training employees will be time consuming					(70)
c. Conversion will result in dual inventories					(71)
d. Customers will be confused by the metric system					(72)
e. Conversion will increase the prices of your members' products/services					(73)
f. Conversion will result in safety hazards and errors.					(74)
g. Sales will be lost to foreign imports					(75)
h. Conversion of building products will require retesting					(76)
i. Building codes and standards will have to be changed.					(77)

16. For your members, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

1 /_7 Advantages significantly outweigh disadvantages (78)

2 /_7 Advantages slightly outweigh disadvantages

3 /_7 Advantages would be about the same as disadvantages

4 /_7 Disadvantages slightly outweigh advantages

5 /_7 Disadvantages significantly outweigh advantages

6 /_7 No basis to judge

17. For the United States overall, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

1 /_7 Advantages significantly outweigh disadvantages (79)

2 /_7 Advantages slightly outweigh disadvantages

3 /_7 Advantages would be about the same as disadvantages

4 /_7 Disadvantages slightly outweigh advantages

5 /_7 Disadvantages significantly outweigh advantages

6 /_7 No basis to judge

18. With respect to small and large firms, who would gain or lose from metric conversion? (Please check one.)

1 /_7 Small firms would gain and large firms would lose (6)

2 /_7 Both small and large firms would gain

3 /_7 Both small and large firms would lose

4 /_7 Small firms would lose and large firms would gain

5 /_7 No basis to judge

19. In the long run, how would metric conversion influence the prices of your members' end products and/or services? (Please check one.)

1 /_7 Major decrease (7)

2 /_7 Some decrease

3 /_7 Little or no change

4 /_7 Some increase

5 /_7 Major increase

6 /_7 No basis to judge

APPENDIX I

F. Schedules - Time Frames for Metric Conversion

20. If the United States converts to the metric system, approximately what would be the shortest time frame for the majority of your members to convert? (Please check one.) (8)

1 [ ] Less than 5 years
2 [ ] 5 - 10 years
3 [ ] 11 - 15 years
4 [ ] 16 - 20 years
5 [ ] 21 - 25 years
6 [ ] 26 - 50 years
7 [ ] More than 50 years
8 [ ] Never

COMMENTS: ______________________________

21. If conversion is not made mandatory, what would be the optimum amount of time your members would need to convert? (Please check one.) (9)

1 [ ] Less than 5 years
2 [ ] 5 - 10 years
3 [ ] 11 - 15 years
4 [ ] 16 - 20 years
5 [ ] 21 - 25 years
6 [ ] 26 - 50 years
7 [ ] More than 50 years
8 [ ] Never

COMMENTS: ______________________________

22. If the United States converts to the metric system, who should establish the date(s) by which your industry would convert? (Please check one.) (10)

1 [ ] Congress
2 [ ] U.S. Metric Board (in consultation with industry)
3 [ ] Building and construction industry
4 [ ] Industry associations
5 [ ] Individual firms
6 [ ] Other (Please specify) ______________________________
7 [ ] No basis to judge

23. If you have additional comments on any of the items within the questionnaire or related topics not covered, please feel free to express your views in the space below or attach additional data. Thank you very much for your cooperation in completing this questionnaire.

CHAPTER 17

HOME APPLIANCE INDUSTRY VIEWS METRICATION AS PREDETERMINED

CHAPTER 17

HOME APPLIANCE INDUSTRY VIEWS

METRICATION AS PREDETERMINED

The prevailing view of the home appliance industry is that the United States will eventually adopt the metric system and thus the industry will have to convert. It believed there is little economic benefit and no necessity for conversion. But, because metrication is seen as inevitable, several major manufacturers are beginning to prepare for it.

Proponents of metrication cite standardization as a major benefit of conversion. However, complete worldwide standardization in the home appliance industry cannot be achieved because electrical supply systems throughout the world are not the same.

In reviewing metrication in the home appliance industry, we interviewed metric officials of three of the largest appliance manufacturers and the Association of Home Appliance Manufacturers. We also sent a questionnaire to the Fortune 500 industrial firms (see ch. 5), and responses included seven companies in the appliance industry. We reviewed available pertinent documents, such as annual reports and statements of metric policy. We talked to Canadian officials involved with their ongoing conversion regarding the appliance industry.

THE INDUSTRY

The home appliance industry consists of companies which manufacture or market major and portable appliances for the home. Major appliances include refrigerators, ranges, washers, and dryers. Portable appliances include toasters, mixers, irons, lamps, and vacuums.

Two characteristics of home appliances are especially important from a metrication perspective. First, major appliances have relatively long lives. Useful lives of 10 years and more are not uncommon. This factor will affect the time frame needed if complete conversion is made from one measurement system to another.

Second, most home appliances require a supply of electric power. Depending on the area of the United States, electricity is supplied to homes at 110 to 120 volts and at a frequency of 60 cycles. Most of the world operates at 220 or 240 volts and 50 cycles. The unit measure of electricity supplied (i.e. volt) is the same in metric and nonmetric countries, but no standard level of voltage has been

adopted worldwide. Because electrical systems differ, manufacturers have worked with these multiple systems in order to trade in world markets. This ability to cope with more than a single electrical system presents an interesting parallel to industry's ability to function using two measurement systems.

CONVERSION WILL HAPPEN SLOWLY

Notwithstanding the general belief that metrication is inevitable, conversion by the industry would be slow and deliberate. If conversion were mandatory, four large manufacturers of appliances informed us that they would need 5 to 10 years to convert. Three informed us they would need more time--anywhere from 11 to 20 years. Even if conversion were not made mandatory, the time frames would not change much. One firm, however, informed us that it would never convert unless conversion was a mandatory requirement.

Officials offered a number of reasons why conversion has been slow to date. A primary reason was that the appliance industry is primarily concerned with meeting the demands of its customers, and they are not demanding metric appliances.

Another reason was that, unlike the automotive and other industries where the industry leader is actively promoting metrication, the leading home appliance firm is taking a passive approach to metrics. This firm believes metrication is inevitable but has no incentive to convert because its major customer, the new home construction industry, is not converting (see ch. 16). Therefore, because this company is a major supplier of electric appliance motors and other components to its competitors, the other home appliance firms which do convert will find it difficult, if not impossible, to get parts built to metric specifications.

A third reason, according to one company official, is the low priority companies assign to metrication. This official said the industry has embarked on a massive program to make appliances more energy efficient. Major engineering, tooling, and designing efforts throughout the entire industry are being devoted to energy-saving programs, and metrication along with other programs has been given lower priorities.

Conversion status of major companies

Although slow, conversion is proceeding. Three of the seven appliance manufacturers which responded to our questionnaire said that they plan for or have in process a formal statement of metric policy and an organization for

implementing that policy. Four manufacturers said that they either have or are working on plans for

--an analysis of the costs of conversion,

--surveys of the capability of suppliers to make components to metric specifications,

--an approach and methodology for training employees in the metric system, and

--coordination with others in the industry.

These responses substantiated one official's statement that a great deal of time is still needed for such things as establishing metric standards for the industry, developing test procedures, retraining employees, and replacing existing equipment with equipment having metric capability.

We interviewed two large major appliance manufacturers which purportedly had metrication programs. One company is a division of a large automobile corporation which has directed all its divisions to convert to metrics. Officials with this appliance division said their conversion to metrics may not be cost justified, but the headquarters directive has influenced this firm to begin converting. This firm estimated that only about 5 percent of its business is metric at this time. The other appliance manufacturer's biggest customer is a major retailer which has been working with its suppliers to gradually metricate.

Metric officers at one company said that their metric policy was to soft convert existing product blueprints and specifications and to introduce hard metric change through designs of new parts requiring new tooling. Officials at the other company told us that since January 1, 1977, their engineering designs and drawings show both customary and metric units. Neither of these two manufacturers has immediate plans for showing both measurement units on appliance labels, packages, or user documentation.

Although they have begun to convert, these two manufacturers will have the problem of interfacing metric and customary components within the same product. The necessity of having to work with a hybrid product is in part caused by the unavailability of certain components like appliance motors and compressors built to hard metric specifications. As a result, one of the above appliance companies is producing portions of a new refrigerator line in hard metric but must interface that portion with customary operating parts.

Association of Home Appliance Manufacturers

This industry trade association is taking a number of steps to meet anticipated future demand for metric products. Included are (1) revision of performance standards for testing, (2) development of a Metric Practice Guide to meet the needs of the industry and the consumer, and (3) identification of other industrys' metrication progress, problems, and solutions. According to an Association official, existing performance standards for appliances have already been soft converted. The Association had a committee working on the next step which is to generate engineering standards for hard metric design. The Association has also proposed SI metric units applicable to the products of its members. These recommended units address measurement-sensitive characteristics of appliances, such as how to express linear dimension, volume, temperature, shelf area, and ice capacity.

One industry representative has said that the trade association will use consumer input in setting standards and making decisions on terminology. Dual measurements will likely be utilized until most adults have been retrained in the metric system. A consumer's understanding of appliance use and care is vital to correct usage. The official said she would like for consumers to "think metric, don't convert," but the industry must be realistic about actual consumer practices.

METRICATION IMPACT

One industry representative told the American Home Economic Association:

> "Conversion to the metric system during the next decade will be one of the most complex processes and comprehensive planning tasks ever undertaken by the appliance industry. Metric changeover involves engineering, drawings, sourcing of components, fitting of parts, inspection, packaging, labeling, test procedure development, inventory records, service parts, meeting industry and government standards, employee training and consumer education."

The Association of Home Appliance Manufacturers, a trade association for the industry, said the appliance industry should encourage and promote the use of the metric system because

--all developed nations have converted or are in the process of converting and

--the Metric Conversion Act of 1975 indicates that the United States will eventually adopt metrics.

This rationale supports the general notion in the appliance industry that metrication is inevitable. In responding to our questionnaire, five of the seven home appliance manufacturers shared that view. Only one firm questioned the inevitability; the other company did not respond to our question on this subject. Officials of home appliance manufacturers generally supported metrication even though they did not believe it is necessary or cost beneficial for their industry.

That is not to say there would be no benefits. The seven appliance manufacturers responded to our questionnaire in the following manner when asked about the advantages frequently attributed to metrication.

Frequently Attributed Advantages

Advantage	Agree	Disagree	Does not apply	No basis to judge
Conversion will provide an opportunity to standardize products	4	3	-	-
Trade will be facilitated through a common measurement language	5	2	-	-
The metric system is easier to use and would result in fewer errors	6	1	-	-
Conversion will provide an opportunity for improving product standards	2	4	1	-
Conversion will increase or protect the present amount of exports and work overseas	4	2	-	1
Use of the metric system will increase production efficiencies	3	3	1	-
Use of the metric system will facilitate technological advances	1	4	2	-
Conversion will stimulate your industry	1	4	1	1

The responses showed general agreement that the metric system is easier to use and would result in fewer errors and that conversion would facilitate trade, provide an opportunity to standardize products, and increase or protect the present amount of exports and work overseas. However, most disagreed that conversion would provide an opportunity for improving product standards, facilitate technological advances, and stimulate the appliance industry.

The seven appliance manufacturers responded to our questionnaire in the following manner concerning the disadvantages frequently attributed to metrication.

Frequently Attributed Disadvantages

Disadvantages	Agree	Disagree	Does not apply	No basis to judge
Conversion will result in dual inventories	7	-	-	-
Conversion will be costly	6	1	-	-
Training employees will be time consuming	6	1	-	-
Product standards will have to be changed	6	1	-	-
Customers will be confused by the metric system	5	2	-	-
Conversion of products will require retesting	4	2	-	-
Conversion will increase the prices of your company's products	2	4	-	1
Sales will be lost to foreign imports	2	5	-	-
Conversion will result in safety hazards and errors	1	5	-	1

Most respondents agreed that conversion would result in dual inventories and be costly, training employees would be time consuming, product standards would have to be changed, customers would be confused, and products would require retesting. Most respondents disagreed that sales would be lost to foreign imports and that conversion would result in safety hazards and errors and would increase the prices of their products.

In Canada, where metrication has progressed further than in the United States, a current industry concern is with the conversion of existing temperature-sensitive appliances, especially those in the kitchen. The dials and knobs on these appliances now show temperature settings in Fahrenheit degrees. When temperature controls and dials are converted to Celsius, consumers may misinterpret the temperature readings

on the dials. A seemingly low temperature reading of 150 degrees Celsius equals about 300 degrees Fahrenheit. The table below shows seven commonly used Fahrenheit temperatures converted to Celsius.

300 F	150 C
325 F	160 C
350 F	180 C
375 F	190 C
400 F	200 C
425 F	220 C
450 F	230 C

If injury were to result, Canadian law does not prevent consumers injured through misuse of metric labels from suing the appliance manufacturer. Dials with dual calibrations might minimize customer mistakes, but this could prolong consumer resistance to metrics because the consumer would continue to use the familiar customary units.

According to an official with a leading appliance manufacturer in Canada, his company's current marketing plans specify that temperature values be shown on control panels and dials of ranges in Fahrenheit and Celsius. This official said his company will introduce metric-only values when certain criteria are met. One of these criteria was the adequate consideration by regulatory agencies, standards-writing organizations, and consumer groups of the safety implications and the possible legal consequences.

In the United States, however, the view of those we interviewed was that safety should not be a major problem. Appliance manufacturers told us that any metric appliances produced in this country would have to satisfy the same safety standards which organizations, such as Underwriters Laboratories, used to test customary appliances before entering the marketplace. Furthermore, they said that except for temperature dials on a limited number of appliances, consumers generally will not even be aware appliances have been made to metric dimensions. According to an official of a large retailer, the only time an appliance user might become aware of the metric measurements would be in replacing parts. But even then consumers may not know because repair parts generally are ordered by code number and not by measurements.

Another concern of the U.S. appliance industry, based on questionnaire responses and interviews, is the role of the Government. Most home appliance manufacturers did not want the Government to mandate metric conversion. They preferred that metrication remain voluntary, believing this would allow

them to convert at a rate most advantageous to themselves and the industry. Most companies believed that target dates would need to be established to assure that conversion within the industry is coordinated. But these officials preferred that this be left to the industry trade association rather than the U.S. Metric Board. They believed the Metric Board should limit its involvement to educating the American public, coordinating and monitoring the country's metric efforts, and recommending legislation needed to facilitate conversion.

LACK OF UNIFORMITY IN INTERNATIONAL POWER SUPPLY

The United States has an electrical power system which generates electric current for domestic use at from 110 to 120 volts and 60 cycles. Europe has 220 volts/50 cycles; England, 240 volts/50 cycles; and Japan, 120 volts/50 cycles and 100 volts/60 cycles. Because electrical systems are not uniform, appliance companies marketing electric appliances here and abroad must adapt themselves to working with different levels of electric current--much like working in two or more different measurement systems.

Officials told us that they have been able to exist in such an environment without much difficulty, although it means sometimes having to sacrifice standardization to a degree and designing different appliances which will perform adequately for a customer in whatever electrical system is in use. For example, an official of a large corporation which sells electric appliances worldwide told us that 95 percent of that company's products were affected by the differences in electric systems. Another official with the same firm said that certain appliances, like electric clocks, were sensitive to the frequency of electric impulses, and his company often builds a frequency switch into these appliances--especially portable appliances. This switch enables a buyer to use the appliance from country to country.

According to one of the officials, if this switching capability does not exist, different things could occur when using the appliance in different countries. He said, for example, that running an appliance on an electrical system capable of producing a frequency of 60 cycles when the appliance was designed for 50 cycles can be done, but the performance level of the appliance would suffer. However, going from 60 to 50 cycles without using a frequency switch could either burn out the appliance motor or substantially shorten its life.

On the other hand, there are appliances with heating elements (like a frying pan or toaster) which are voltage

sensitive. These appliances also often have a switch to accommodate voltage at various levels. The official said his company must design separate motors, however, for appliances to be marketed where higher voltage is used. A transformer can be used to adjust voltage, but cost makes this an impractical alternative in most cases to designing a separate motor.

In all probability neither the United States, Europe, nor Japan will convert its electrical system to conform to a worldwide standard system.

CONCLUSIONS

The prevalent view in the American home appliance industry is that metric conversion is inevitable. Little conversion activity has occurred, however, because there has been little customer demand for hard metric appliances, and appliance manufacturers see no substantial benefits occurring.

It is too early to tell what real impact conversion would have on the home appliance industry. Nevertheless, company officials have advised us that conversion would be costly, and there would be need to maintain two inventories, train employees, change product standards, and retest products. Although manufacturers are concerned about customer confusion occurring, they generally do not believe that metrication of home appliances would result in safety hazards and possible litigation from appliance users. However, this concern has surfaced in Canada.

The lack of uniformity in power supply systems shows that the appliance industry is capable of meeting differing demands. It also demonstrates that the world can exist on more than one system, be it electrical supply or measurement, particularly if conversion would be costly.

CHAPTER 18

THE COMPUTER INDUSTRY REMAINS DIVIDED

CHAPTER 18

THE COMPUTER INDUSTRY REMAINS DIVIDED

Whether or not to convert to the metric system has divided the computer industry since the late 1960s. Those companies favoring metrication--mostly the large multinational companies--have begun converting some operations to the metric system. These companies generally believe they would benefit by adopting one measurement system in their worldwide engineering, production, and marketing operations. The rest of the industry, some multinationals included, were not converting because they saw no benefits. They felt conversion would bring problems and added costs to their companies.

THE INDUSTRY: WHAT IS IT?

The computer industry is represented by some of the better known and largest corporations in America. It manufactures, sells, and supports all types of data processing and business equipment, such as general purpose computer systems, minicomputers, small business computers, and various related equipment. Each product category has a dominant company.

Several trade associations act as spokespersons for the computer industry, but the Computer and Business Equipment Manufacturers Association can be the most influential because it represents those companies having the bulk of the industry's sales. A major function of this Association is to write performance and interface standards for the entire industry. The Association is also the sponsor approved by the American National Standards Institute for all standards projects, domestic or international, in both the computer and office machine areas.

In the past 20 years the computer industry has grown more than any other industry in America, according to an Association official. This growth has meant dynamic progress and constant change, characteristics which may ultimately work to the industry's advantage in implementing the change to metrics.

Our review of metrication in this industry was limited to discussions with top metric officials at 13 firms--both large and small. We verified and supplemented our interview information with the questionnaire responses received from those computer corporations listed among the Fortune 500 companies. (See ch. 5.) Where possible we reviewed the annual reports of these corporations as well as any metric statements, policies, plans, and handbooks that were available.

We also talked with metric officials at the Computer and Business Equipment Manufacturers Association.

METRICATION DIVIDES THE INDUSTRY

Without an industry position on metrication, most companies have decided against conversion even though they believe it is inevitable. However, some companies have decided to convert and are studying how to proceed. Their experiences have been both good and bad.

Industry interest in metrics gained some momentum in 1968. That was the year the Computer and Business Equipment Manufacturers Association formed its first metric committee. The committee's sole purpose was to respond to a National Bureau of Standards questionnaire. In its formal report to NBS, the Association concluded it could not take a position on metrication because some companies favored metrication while others opposed it. The Association's policy was to support the consensus; therefore, because there was none, the Association's metric committee was abolished.

Then, in 1973, the Association became a charter member of the American National Metric Council. After 1 year, according to an official, the Association dropped out because there was still no computer industry interest in metrication. In 1974 and again in 1975, ANMC asked the Association to be Secretariat for a new committee representing the computer and electronics industries. The Association refused because a survey of its membership showed no interest in supporting or participating in such a committee.

An Association official recently told us that few members expressed even a casual interest in becoming involved with metric conversion; therefore, the Association has not been involved in planning and preparing for it. However, several firms which had experimented with metrics on their own over the years had mixed results:

--In 1973 one company began designing a product in hard metric units but soon found the metric fasteners and supplies needed were not available. The result: significant redesign of the product taking about 3-1/2 staff-years to complete. This product ended up with only about 20 percent of the components designed in hard metric. This same company tried again in 1975 but dropped its project due to similar problems and a lack of vendor capability. A company official said that both experiences were very costly but he could not be more specific than that.

--One of the industry's leading companies in 1974 designed one of its products in metric units. When the firm found it would have to pay as much as a 20-percent premium for metric parts and supplies, the company scrapped the idea and redesigned the product mostly in customary units. This same company developed a metric plan for implementation by January 1976 but did not implement it because management found only a few companies in the industry were taking conversion seriously. Management did not want to pay the price of being a metrication leader and, consequently, shelved the program.

The above two companies do not have active metric programs today. However, a small group of multinational companies, including the industry leader, were more successful in implementing their metric programs. They have:

--Statements of metric policy calling for a gradual implementation of metrication with new product designs while leaving existing products alone.

--Metric plans which usually specified time periods by which the company would be predominantly metric, usually a 10-year period.

--Committees or coordinators responsible for implementing and monitoring metric policies and plans.

--Some products already converted to metric; e.g., computer terminals and housings for computer mainframes.

Officials with these multinational companies said they are converting because metrication is inevitable. Several officials also said that a primary consideration in their company's decision to convert was the European Economic Community directive that after April 21, 1978, all goods sold in Europe must be labeled in metric units.

The largest computer corporation in the United States decided in 1966 to study the possibility of conversion to the metric system. Its primary reasons for doing so were that (1) a new computer series was being developed for worldwide use as a single integrated computer line, and (2) the company wanted to expand its manufacturing capabilities worldwide.

Company officials believe they are successfully progressing toward their goal of being predominantly metric by 1982. They attribute their success in large measure to the corporation's international background and past metric experiences with foreign subsidiaries. Also, metrication has been given

top-level approval and support. Plans have been developed and staff provided to assure implementation. The corporate standards group established an interdivisional steering committee with every division represented. The committee met two or three times annually to discuss program status and problem areas. Responsibility for the overall metric program is centered in the committee chairman. Each division manager is responsible for setting timetables for converting his operations so that the overall corporate goal would be achieved.

Not all multinational computer firms, however, believe metrication is inevitable. An official with one of the leading computer firms said he could understand some multinational corporations going metric because they had no single standard for their worldwide operations and one standard--either metric or customary--is desirable. Metrication would allow them to adopt a standard used throughout the world. In discussing his company, however, this official said it already has one standard which is used throughout its global operations. Its standard is the customary system of measurement.

The official further stated his company is getting no pressure from foreign markets to manufacture and sell metric products. The company has no problem selling its products in overseas metric markets or getting them serviced. Consequently, this company will use the customary system until it costs more to use it than to convert to metrics. It plans to monitor metric developments around the world through a network of metric committees.

PROBLEMS AND COSTS, BUT FEW BENEFITS

Most industry officials believed that metric conversion would bring added costs, and in several cases, officials believed this cost could be substantial. But actual cost experiences were limited; therefore, no one in the computer industry really knew how much metrication would cost. Only three companies we visited had tried to estimate what their costs would be.

One company in 1971 estimated its conversion costs at from several hundred thousand to several million dollars if conversion was completed in a 3- to 5-year period. The company's study involved all areas of the corporation and sought supplier reactions to furnishing metric components. An official said suppliers generally were willing to provide the company with any metric items needed. However, this company has since decided not to convert with one reason being the cost that would be incurred.

In 1963 a second company estimated its costs would be $3.6 million over a 10-year conversion period. But then in 1971 it revised its estimate to $1.1 million, again stretched over a 10-year transition period. The company lowered its estimate because it concluded that conversion would not require wholesale discard and replacement of costly manufacturing tools and equipment. On the other hand, the company believed that costs of employee education and training would be substantially higher.

The third company refused to discuss its 1966 cost estimate other than to say that the company's study team estimated that the costs would amount to many millions. Despite the high costs, the team recommended increased use of the metric system. It believed metrication was in the corporation's best interest in the long run.

Management at one large corporation is convinced some cost data, regardless of how crude it might be, is needed to set priorities and generally assure some management control. Many multinational computer firms converting are following a policy of letting costs lie where they fall within the companies. They hope that managers, operating without a budget for metrication, would be resourceful and implement metrication with minimum costs.

The impact of metrication in cost and problems will vary from company to company. Industry officials have different opinions as to which areas of their business would be most affected by metrication. One problem almost always mentioned, however, is the need to maintain two inventories--one for metric products and another for customary products--for many years. Officials' estimates of how long dual inventories would be required varied and ranged from 10 to 30 years.

Besides the inventory problem, officials generally believe their companies are likely to incur costs in the following areas:

--Some employees will need metric tools in their work. One company, for example, has over 12,000 field engineers who probably will require some metric tools for computers having metric components. An official of this firm did not know whether the company or the employee would pay for the added cost of buying the metric tools.

--The need to show two sets of measurement units on engineering drawings, and how to show them, could be a problem. One company estimated that using the two measurement systems on its engineering drawings would

add 5 percent to the total cost of the drawings. Another company also found it was costing more than it was worth and stopped this practice after 8 years. The company now shows either only customary or metric units on its drawings.

--Metric conversion will require changing numerous product standards to either a hard or soft conversion. Almost every product standard in the industry is now expressed in customary units.

--Training programs with training materials and documentation will have to be developed for employees. Employees may lose work time while in training, and there may be initial productivity decreases as employees learn to work with metric units. One company, for example, had developed a training program which will have an impact to varying extents on every employee in the company.

--The availability of metric parts, at least initially, is a concern. Several companies told us they have already had difficulty in locating metric sources, and after locating them they had to pay higher prices than for customary parts.

--Metric conversion could create safety problems. Some manufacturing processes, for example, are temperature controlled, and an employee could get injured by confusing Celsius and Fahrenheit readings. One company told us that one of its machinists unknowingly working with metric numbers was almost injured. He miscalibrated his machine which caused the tool to break and fly off the machine.

--Computer programs may need to be modified or completely rewritten. In prior reviews of data processing systems, we have found that program modifications can be an expensive and prolonged process, especially if the documentation supporting the existing program was not complete or had flaws in it.

Most companies, including those in the process of converting, associated few or no benefits with metrication. One benefit cited was that metrication would make the U.S. corporations more competitive in the world market. A vice president of a leading computer firm claims this is nonsense. He said the biggest impediment to marketing overseas is that the product is American, not that it is in customary measurements. According to this official, all countries today use standards as a trade barrier to keep U.S. products out and this will

continue regardless of whether the United States goes metric or not.

Another benefit often cited was that metrics would provide an opportunity to standardize products. However, one official with a major corporation told us that achieving universal interchangeability and standardization involves more than just agreeing on linear dimension, which is the only thing metrication addresses. This official believes the emphasis on metrication sidesteps the real obstacles to attaining worldwide standardization, such as

--the different methods engineers around the world use to draw things and the need to redraw these drawings before transferring them from abroad to the United States,

--the different material specifications in use from country to country and the need to redesign components to use foreign specifications,

--the limited vendor competition abroad because these vendors have to convert American drawings to local standards and local language, and

--the language barrier between the countries of the world which often results in poor and inaccurate communications.

By adopting hard metric standards for its computers and business equipment, the computer industry would also be in a position to seriously begin considering the use of hard metric paper sizes with its machines. The internationally sanctioned metric paper size system is said to contain many benefits, not the least of which is a much simpler way of expressing the weight of paper than is done in the United States today.

But a major obstacle to adopting this paper system is that the equipment manufactured by the computer industry and used throughout the world is built to inch specifications, and metric-size paper is currently not compatible with this equipment. For example, automatic business machines that add data to preprinted business forms use feeding devices employing pins spaced at 1/2-inch centers. This requires that continuous forms have feed holes punched at 1/2-inch intervals and that form depths be in multiples of this module.

The issue of paper size is very complicated and one that representatives of the computer, paper, and printing industries were jointly studying as a subcommittee of ANSI. Any

change to our system of paper sizes would have an impact on things, such as filing systems, filing equipment, and paper-making equipment.

The subcommittee considered the pluses and minuses of conversion for business paper and concluded that changes to paper sizes must necessarily be limited to a soft conversion because computer and business equipment will be soft converted for the short term. Thus, it appears that an American commitment to an international metric standard for paper sizes will not be achieved, at least in the near future. (See ch. 19 for a discussion of the international metric paper size system and the advantages and disadvantages to using that system.)

FUTURE METRICATION EFFORTS

Metric officials with one of the industry's largest companies were convinced the United States would not complete metrication until the next century if conversion continued to be voluntary. They believed a national program with plans and timetables is needed. Officials at other computer companies shared this view and stressed the need for a short conversion to keep confusion and costs to a minimum.

Some officials wanted a voluntary program but disagreed on what the Government's role should be regarding metrication. Two large companies believed that the Government should provide companies with some form of incentive to convert. The particular incentive desired in one case was some form of tax relief to keep metric costs down. The other company believed conversion should proceed voluntarily up to a point, predetermined by the Government, after which everything would be converted. One official of another firm cautioned that the Government should not subsidize metrication for anyone because to do so would bring chaos and add to total conversion costs.

Officials of one major company said that the American people should have a voice in deciding whether the United States should convert to the metric system. The company believes public opinion should be assessed by the U.S. Metric Board. According to the officials, if the Board determines the American public does not want metrication, the country should continue with soft conversion where appropriate and determine a new course of action. Regardless of any future national decisions, however, this company will continue to convert its operations. The company believes it could operate in two measurement systems although it would prefer just one--the metric system.

CONCLUSIONS

The computer industry remains divided on whether or not metrication is necessary. Certain large multinationals within this industry believe conversion is inevitable and are preparing for it. Other companies, including multinationals, still vigorously oppose conversion because they see no benefits.

The industry does not know whether metrication is a cost-beneficial business decision. Rather than thoroughly evaluating costs and benefits, companies are deciding to convert because of what they claim is the inevitability of metrication. Few benefits are being cited, yet the few cost studies made show companies will incur added costs to become predominantly metric. It appears that this industry will remain divided. However, if the United States decides metrication is best, many corporation officials would favor a quick conversion over a prolonged one to minimize confusion and cost.

CHAPTER 19

LITTLE CHANGE IN BUSINESS-LETTER SIZES

10 1/2 INCHES

8 INCHES

CHAPTER 19

LITTLE CHANGE IN BUSINESS-LETTER SIZES

The paper industry does not plan to accept the proposed international metric standard size for business paper. The importance of keeping the current size is that most filing systems, business machines, and other products were made to fit the business letter; and consequently, other record paper and forms were designed to conform to this size.

While the United States does not have a formal national standard business letter size, by general custom the common business letter size is 8-1/2 by 11 inches. The Federal Government uses 8- by 10-1/2-inch sized paper as its standard size.

Our review of the paper industry was limited to the metrication activity surrounding the correspondence- and business-size paper and forms. We discussed the paper industry's metrication activities and the business paper size problem with representatives from industry associations and manufacturers.

PAPER INDUSTRY BACKGROUND

The American Paper Institute is the industry's national trade association. Its approximately 200-member firms provide more than 90 percent of all pulp, paper, and paperboard manufactured domestically. The paper industry ranks among the six largest industries in the United States and last year produced over 60 million tons of paper and paperboard. The paper and allied products companies employ approximately 750,000 people located throughout the Nation.

The Institute participates in the International Organization for Standardization's meetings concerning international paper standards. Also, the paper industry, in cooperation with the American National Metric Council, has established a paper and allied products industry sector to plan conversion activity with the Institute as the secretariate. This sector committee has established 12 subcommittees for the industry. These subcommittees are: papermaking and other fibers, newsprint, printing-writing papers, packaging paper, sanitary tissue products, specialty papers, corrugated and solid fiber boxes, folding carton and food service products, paperboard other than packaging, machinery manufacturers, units and testing instrumentation, and employee training.

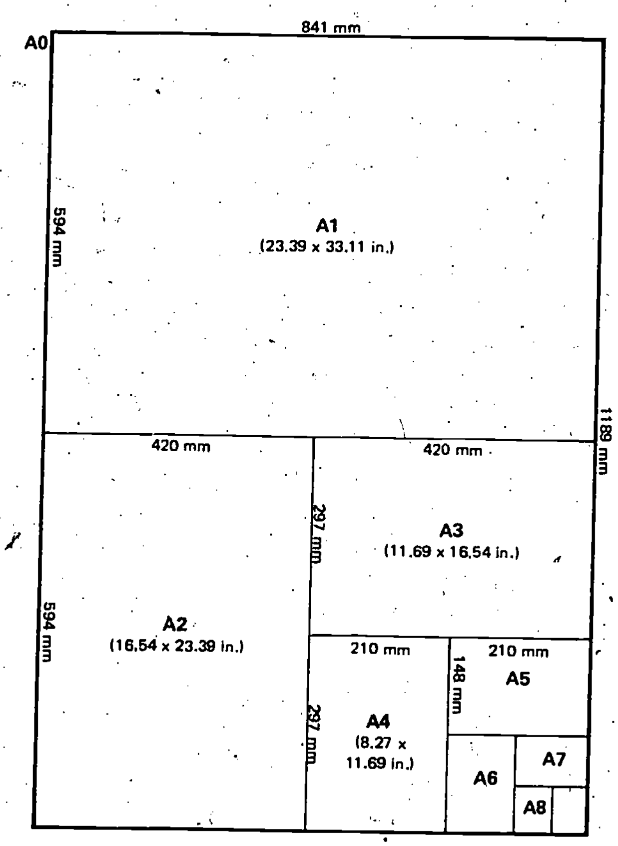
An Institute official informed us that, overall, the paper industry would soft convert but, for the most part, be responsive to the customers needs. Therefore, there may be

some hard conversions. We were informed by a manufacturing official that a hard conversion would require some adjustments to plant equipment; for example, to cut the finished product to the dimension ordered. However, most of the metrication activity would result in changes to the labeling, billing, and other business systems. Also, metrication would require some training of employees in the metric system.

INTERNATIONAL STANDARD PAPER SIZES

ISO's standard for paper sizes is a system of paper sizes based on the concept that all paper sizes can be derived from a 1-square-meter sheet of paper having a width to length ratio of 1 to 1.414. This preferred basic sheet of paper is a rectangle measuring 841 by 1,189 millimeters. To produce the succeeding sizes, this sheet is cut in half. The resulting sheets are one half the area of the previous sheet. This process can be continued to produce a series of about 10 useful sizes called the A-series of paper sizes. The business-size paper is the A4 size--210 by 297 millimeters or 8.27 by 11.69 inches.

The following figure shows how the A-series of paper is derived from a 1-square meter sheet.



The following table lists the A-series paper sizes.

Size	Millimeters	Inches
A0	841 by 1189	33.11 by 46.81
A1	594 by 841	23.39 by 33.11
A2	420 by 594	16.54 by 23.39
A3	297 by 420	11.69 by 16.54
A4	210 by 297	8.27 by 11.69
A5	148 by 210	5.83 by 8.27
A6	105 by 148	4.13 by 5.83
A7	74 by 105	2.91 by 4.13
A8	52 by 74	2.05 by 2.91
A9	37 by 52	1.46 by 2.05
A10	26 by 37	1.02 by 1.46

ISO standards for paper also include a similar B series to be used when paper sized between any two A-series sizes is needed. The following table list the B series sizes.

Size	Millimeters	Inches
BO	1000 by 1414	39.37 by 55.57
B1	707 by 1000	27.83 by 39.37
B2	500 by 707	19.69 by 27.83
B3	353 by 500	13.90 by 19.69
B4	250 by 353	9.84 by 13.90
B5	176 by 250	6.93 by 9.84
B6	125 by 176	4.92 by 6.93
B7	88 by 125	3.46 by 4.92
B8	62 by 88	2.44 by 3.46
B9	44 by 62	1.73 by 2.44
B10	31 by 44	1.22 by 1.73

A STANDARD BUSINESS-LETTER SIZE

The question of a standard size, be it ISO or a U.S. standard, is separate from the use of the metric system, and the two could be considered separately. However, they appear interrelated because (1) consideration and planning for the paper industry's adoption of the metric system and (2) the proposal that the U.S. paper industry adopt the international paper size are occurring at the same time.

Two subcommittees of the American National Standards Institute have been studying the optimum metric size for business letters from the viewpoint of paper manufacturers, printers, and users. They have also been working on (1) the problem of the difference in the sizes between Government and commercial business letters and (2) the effects of adopting ISO sizes.

If the size of the business letter is to be converted to the metric system, the paper industry has the following options:

1. Soft convert the present size of 8-1/2 by 11 inches to 215.6 by 279.4 millimeters.

2. Soft convert the present size with the dimensions rounded to 215 by 280 millimeters, which is 8.46 by 11.02 inches.

3. Adopt the A4 size, 210 by 297 millimeters, which is 8.27 by 11.69 inches.

4. Hard convert and adopt a new size, 210 by 280 millimeters, which is 8.27 by 11.02 inches.

The compromise size of 210 by 280 millimeters, or 8-1/4 by 11 inches, would preserve the 11-inch length dimension needed for our existing filing system and business machines; and the adoption of A4 width, 210 millimeters or 8-1/4 inches, could make international uniformity in envelopes possible.

At this point, there is general agreement within the paper industry to continue using 11-inch lengths. Eleven inches is 279.4 millimeters. Rounding this to 280 millimeters would only increase the present length by 0.0016 of an inch, well within existing tolerances. The question of width, however, is still unresolved. The advantage of adopting the A4-size width, 210 millimeters (8.27 inches), is that it only reduces the present size by about 1/4 inch, and this uniform width could permit the international standardization of envelope sizes.

Presently, the Federal Government has not done anything to adopt the compromise size. Also, ISO has not been willing to introduce the 210- by 280-millimeters size as an alternate size in the A series. An Institute official advised us that the paper industry will just soft convert the present 8-1/2- by 11-inch size. The paper sizes will not change until the Government and ISO have agreed with the paper industry on a standard size for use in the United States that recognizes or adopts the 11-inch length dimension.

DISADVANTAGES AND ADVANTAGES OF INTERNATIONAL PAPER SIZES AND STANDARDS

Disadvantages

Industry officials told us that the adoption of ISO's system of paper sizes would present some problems, especially

with the use of business machines, because the machines would have to be modified or replaced.

The paper sizes used in automatic writing and reading machines are usually dictated by the dimensions of the machine. An industry official stated that many of the A series paper sizes are not readily adapted for use on high-speed printers and are not well suited for printing on presses. However, these automatic systems are necessary to process the increasing volume of business transactions.

As an example, the increase in the volume of bank checks to be processed made automation necessary. Machines were designed to handle a range of check sizes, but the check must be between 6 and 8-3/4 inches by 2-3/4 and 3-2/3 inches. The A-series size recommended for checks is A6 (105 by 148 millimeters or 4.13 by 5.83 inches) and will not work in the automatic readers. The suggested solution is to use one fourth of the A4 size, which would be 210 by 74 millimeters or 8.27 by 2.91 inches. This manipulation does produce a size that is acceptable to the reader, but but it cannot be used in automatic writing machines.

All business machines that automatically write data on continuous paper or forms use feeding devices with pins spaced at 1/2-inch centers. This requires that continuous forms have feed holes punched at 1/2-inch intervals and that their lengths be in multiples of this module. This requirement eliminates the A-series size for use. The A4 size has a length measurement of 297 millimeters, or 11.69 inches. The U.S. commercial size has an 11-inch length. The use of continous processing paper and forms seems to be certain; therefore, to change all automatic data processing equipment printers and other business machines with 1/2-inch spacing does not seem to be justified.

Another problem with adopting the A4-size business paper would be the need to change the sizes of other office-related products which have been built to accommodate the 8-1/2- by 11-inch business paper size; for example, desks, filing systems, binders, etc. This problem, however, does not exist when you use something less than the 8-1/2- by 11-inch size. For example, the Federal Government's 8- by 10-1/2-inch size can be used with the office products designed to accommodate the 8-1/2- by 11-inch size paper.

The Standards Council of Canada (Canada's national standards organization), after studying the problems of the 11-inch length and the need for 1/2-inch spacing for business machines and learning that ISO was not willing to add a compromise size to the A series, has standardized on the

8-1/2- by 11-inch business-size paper. Therefore, the A-series size may be an international standard size, but it is unlikely that it will be adopted worldwide.

Advantages.

Other features of ISO's paper standards are less controversial. The ISO system includes standard envelope sizes that are coordinated with the standard paper sizes. It uses the grammage concept, a metric measurement, for paper weights.

It would be more economical for the United States to use a limited number of envelope sizes to meet all mailing needs instead of the hundreds of sizes now used. However, it is not necessary to convert to the metric system to accomplish this. Many of the odd-size envelopes used are selected for their attention value in direct mail advertising and greeting cards.

In addition to size, paper manufacturers and users also define the substance or basis weight of a particular grade of paper. This basis weight is defined in pounds of a ream of paper cut to a given size. This method of describing paper can be eliminated with the use of the metric system.

The grammage method expresses basis weight of paper in grams per square meter. The concept eliminates confusion over each basis weight of different quality paper cut to different sizes by providing a common unit for comparing sheet weight. The customary ounce unit is too large to be used. Further, in the metric system, ream weight is reported in kilograms per 1,000 sheets, thus providing a distinction between sheet weight.

CONCLUSION

Metrication of business paper is not a simple task even though the paper manufacturer could probably change the size of paper easily. The U.S. paper industry has considered Canada's decision to retain the 11-inch length for business paper. Further, to take advantage of international standardization of envelopes in the future, it has proposed adoption of the 8-1/4-inch width.

The paper industry wants to be responsive to customer needs and keep the economic impact to a minimum. Therefore, it plans to retain the 11-inch length dimension so that filing systems, business machines, and other products do not have to be modified or replaced.

CHAPTER 20

SURVEYING AND MAPPING: SOME FAMILIARITY WITH METRICS

CHAPTER 20

SURVEYING AND MAPPING: SOME FAMILIARITY WITH METRICS

Measurement is extremely important to those involved in surveying and mapping. Metric units have been used to some extent in various phases of the profession for many years, and some of the data base is already metric. However, the customary system is the predominant system used.

Conversion to a predominant use of the metric system would not significantly benefit surveyors and mappers. However, some benefit would result from a single, uniform measurement system on a worldwide basis. Mappers would benefit to some extent in that some of the data base is already metric, and the cost and time required to convert this data to customary units would be eliminated.

Surveyors and mappers did not expect metrication to present major problems as long as the "go forth" approach is followed. This means that existing land deeds and plots would not be resurveyed (in metric) until the land was resold or there was another need for the survey to be redone. Maps would be converted when they are revised or new ones are prepared. Exceptions to the go forth approach could be aeronautical charts and road maps.

We discussed metrication of surveying and mapping with the three major mapping agencies--the U.S. Geological Survey, the National Ocean Survey, and the Defense Mapping Agency--and several surveying firms and private map producers. Discussions were also held with the American Congress on Surveying and Mapping and the ANMC Surveying and Mapping Sector Committee. We also examined pertinent documents.

MAPPING

Many different types of maps are produced, including aeronautical, nautical, topographic, and special-purpose, such as road, recreation, and engineering. These are produced by Federal, State, county, city, and private groups. Most of the basic cartographic (chart and mapmaking) work is performed by Government agencies because private interests do not have the required resources. Maps prepared by the Geological Survey and other government agencies serve as the basis for many other maps.

Aeronautical charts

With some exceptions, aeronautical charts are prepared by the Federal Government. The National Ocean Survey of the

Department of Commerce's National Oceanic and Atmospheric Administration prepares, publishes, and distributes aeronautical charts of the United States. Charts of foreign areas are prepared and published by the Defense Mapping Agency of the Department of Defense and are sold to civilian users by the Ocean Survey. These charts are used in military, commercial, and general aviation.

Aeronautical charts of the United States and many other countries are almost exclusively in the customary system with altitude in feet and distance in nautical miles. 1/ The Ocean Survey prepares its aeronautical charts in accordance with Interagency Air Cartographic Committee--Federal Aviation Administration, Department of Defense, and Department of Commerce--specifications. The Ocean Survey cannot unilaterally convert its aeronautical charts. Defense Mapping's aeronautical charts are prepared in accordance with standards established by the International Civil Aviation Organization. This international organization was considering January 1985 as a possible target date for conversion to metric. Neither the Ocean Survey nor Defense Mapping have any plans to metricate aeronautical charts. (See ch. 15 for a discussion of the impact of metrication on aviation and the aerospace industry.)

A concern if metric conversion of aeronautical charts were to take place is that for some period of time pilots may have to use both customary and metric charts. Ocean Survey and Defense Mapping officials told us that any confusion over meters and feet could result in safety problems (A meter is over 3 times greater than a foot--the commonly used unit.) For this reason, these officials believed that conversion of aeronautical charts would probably be done as quickly as possible if and when a decision was made to convert aviation to the metric system.

This would mean that charts in use, for the most part, would have to be revised to show metric dimensions. A less costly approach would be to convert the charts as they are normally updated or new ones prepared. It would be many years, however, before all charts would be converted under this approach.

Some conversion costs would be offset by savings that would result because some data is already metric. Mapping data is often exchanged between various mapping groups, both

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1/The nautical mile is an international unit of distance for sea and air navigation based on the length of a minute of arc of a great circle of the earth. It equals 1,852 meters or 6,076.115 feet.

domestic and foreign. Some of this data would already be metric because it would be generated by metric countries. Defense Mapping also gathers data on foreign areas in metric. In addition, the national geodetic network 1/ has been in metric, probably since the first survey in 1830. The network provides much of the basic data base for mapping in the United States.

Defense Mapping and Ocean Survey officials said conversion of metric data to customary is a minor problem, but some expense is involved. The cost, however, is unknown.

Decisions on whether and how aeronautical charts are to be converted to metric would not be made by the mapmakers but by the Interagency Cartographic Committee and the International Civil Aviation Organization. Any plans to convert aircraft operation should take into account the cost and any problems that may be involved in converting aeronautical charts. If a decision is made to convert aircraft operations, a target date for conversion would be needed in order that the preparers of aeronautical charts could plan for conversion.

Nautical charts

The Ocean Survey charts the coastal waters of the United States and its territories and the Great Lakes. Defense Mapping is responsible for international waters, and the Army Corps of Engineers charts the Nation's rivers. Some private firms reformat and reproduce Federal nautical charts for their own varied uses.

Nautical charts are mostly customary with feet and fathoms (6 feet) used for depth of water and nautical miles generally used for distance. It has been the custom to use the statute mile for distance on the Great Lakes.

The Ocean Survey has been involved in two metric projects. As part of an agreement with the International Hydrographic Organization (an organization of maritime countries

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1/The national geodetic network is a system of bronze markers implanted in the earth's surface at over 500,000 locations that give, with great accuracy, the longitude and latitude and/or elevation of each point. This system, which is established and maintained by the National Ocean Survey, serves as the primary reference system for surveying and mapping of the United States and is the basis for much of the mapping data. The data is converted to the customary system because nearly all its users are on the customary system.

which works to standardize charting symbols and specifications), the Ocean Survey developed five charts of the North Pacific Ocean which give depths in meters and distances in nautical miles. The second project was a chart of Lake Erie prepared in conjunction with the Canadian Government. The chart is in metric on one side and customary on the other. Although a couple of similar metric charts are planned, the Ocean Survey has no plans to convert other nautical charts until there is a demand for metric charts. An Ocean Survey official said that metrication offers no benefit for the agency.

Defense Mapping began converting its nautical charts to metric about 10 years ago. As the charts are routinely updated, they are converted. New charts are prepared in metric. About 30 percent of the charts are metric. The widely used nautical mile is being retained as opposed to the kilometer for distance. Much of the Defense Mapping's nautical charting data is obtained from foreign (metric) countries. Therefore, the time and expense that was required to convert the data to customary is eliminated.

According to Defense Mapping and Ocean Survey officials, nautical charts cannot be readily converted because direct conversion of fathoms and feet to meters would yield "awkward numbers" with which the user would have to work. It would be necessary to go back to the data base and select numbers that would equal round metric numbers. Conversion of all nautical charts within a relatively short period would be expensive and time consuming.

Topographic maps

Topographic maps are a detailed record of land area giving geographic position and elevations for both natural and manmade features. They show the shape of the land--mountains, valleys, and plains--by means of contour lines. Topographical maps are used for such purposes as evaluating natural resources and land-use planning. They are also used in many kinds of geological and hydrologic studies, such as dam siting, highway and communication systems planning and construction, and flood control, soil conservation, and reforestation programs. They serve as the bases for more specialized maps, such as road, census, weather, and landownership.

The major producer of topographic maps of the United States is the U.S. Geological Survey of the Department of the Interior. Its mapping program consists of various small, intermediate, large-scale and special-area maps. The major map product, however, is the standard quadrangle map. These

maps cover a four-sided, almost rectangular area bounded by 7.5 minutes of longitude and 7.5 minutes of latitude. They are prepared to a 1:24,000 scale (1 inch on the map equals 24,000 inches or 2,000 feet on the ground) with contours in feet. Eventually, the continental United States will be covered by these maps. About 60 percent of the required 55,000 maps have been prepared.

The Geological Survey's metric policy and conversion plan for its mapping program is to pursue a policy of proceeding with metrication as soon as possible, compatible with production goals and objectives and with due consideration for map users' needs. New and completely revised small-scale, intermediate-scale, and special-area maps will be prepared in metric. Completely revised standard quadrangle maps will also be done in metric. New standard quadrangle maps will be prepared to either a 1 to 25,000 scale (1 centimeter on the map equals 25,000 centimeters or 250 meters on the ground) with metric contours or a 1 to 24,000 scale with contours in metric or customary for the time being, depending on the unique situation in each State. They will be prepared to a 1 to 25,000 scale with metric contours if the appropriate State officials agree. If State officials prefer to complete a State at the conventional 1 to 24,000 scale only to maintain scale continuity, the maps will be done at the conventional scale but with metric contours. A State can delay metric conversion until it has been completely mapped in customary. Thereafter, complete revisions of the standard quadrangle maps would be in metric.

The metrication policy was developed after the Geolological Survey's mapping services users were solicited for their views on how its products should be converted to metric. With regard to the standard quadrangle maps, officials of 32 States said to complete their States at the 1 to 24,000 scale. Officials of 10 States wanted to begin metric mapping immediately, but 5 States had been completely mapped at the 1 to 24,000 scale. The users were asked how conversion should be implemented and not whether it should be. The Geological Survey's mapping division considered the national intent to be conversion to the metric system.

The Geological Survey has about 40,000 published maps. The time frame for converting these to metric will depend on the availability of funds. The published maps could be converted in a relatively short period, possibly 3 years, with a massive infusion of funding and personnel. Conversion could cost almost nothing if metrication occurs only when maps are scheduled for complete revision. However, under this approach, conversion may take several decades. Geological Survey officials consider a more practical approach to be a

combination of the above two approaches with annual funding to convert a certain percentage of maps, with others being converted when completely revised. This would require about 10 years.

Defense Mapping supports the Department of Defense in its land operations by preparing topographic maps for use in these operations. The Army had used the metric system to a large extent in its mapping operations. This policy continued for topographic maps when the mapping operations of the Army, Air Force, and Navy were combined into the Defense Mapping Agency in 1972. Thus, Defense topographic mapping is performed, to a large extent, in metric. The maps are in accordance with requirements set by the North Atlantic Treaty Organization (NATO) and the Southeast Asia Treaty Organization.

The Department of Defense will benefit from the Geological Survey's conversion to the metric system in its topographic mapping. Military troops have used Geological Survey maps--which have been in the customary system--for training in the United States. When the troops were abroad, they had to adjust to metric maps. Geological Survey's conversion will eliminate this problem.

Special-purpose maps

Industries and planning agencies use the maps of the Geological Survey and other Federal and State agencies as the bases for more specialized maps. Scales and details can be adjusted to suit individual needs. Specialized data can be superimposed directly on the base maps. For example, some of the special adaptations of topographic maps are census maps, planning maps, drainage basin maps, flood zoning maps, industrial zoning maps, National Park maps, population maps, weather maps, land-use and crop maps, road and street maps, and recreation maps used by the public for hunting, fishing, hiking, and boating.

There are an estimated 300 mapping firms in the United States. Many firms are familiar to an extent with the metric system. Some have produced metric maps for clients in Puerto Rico and foreign countries. A limited amount of metric mapping has been performed for U.S. clients, such as Defense Mapping.

Mapping firms can work in both metric and customary without much difficulty. A changeover to metric would depend on requests by clients. Very few clients are presently interested in metric maps. Generally, the mapping firms we contacted stated that they do not anticipate any significant

benefits, and there would be some costs. In absence of demand by clients for metric maps, conversion would probably have to be mandated. Conversion of Geological Survey maps will not influence private mapping firms to convert their special-purpose maps. The data can be converted to customary and the scales can be adjusted rather easily.

The general public may be more familiar with road maps than any type of special-purpose map. Many U.S. road maps have bar scales in both miles and kilometers. Some of the road map producers' world atlases are in metric. The rest of the data, however, is generally in customary.

None of the road map producers we interviewed had definite plans to begin producing metric road maps. One large firm plans to recommend to its customers that distances be given in both metric and customary units. Another producer believed that not enough space would be available on its maps for dual numbering.

Further metrication of road maps would probably take place when customers want it. This would probably coincide with conversion of road signs.

The road map producers we contacted generally did not believe that conversion of road maps would be beneficial except for the consistency with road maps of Mexico and Canada. Generally, no significant disadvantages were anticipated. One producer, however, was concerned with the cost and manpower needed to convert the 200,000 items (distances, elevations, etc.) on its maps. These costs could increase the prices of its maps.

SURVEYING

Measurement is extremely important to those in the surveying profession. Although traditional units such as the chain (66 feet) and the rod (16 1/2 feet) are still used to a limited extent, the foot and decimals of a foot are generally used in performing surveys. The meter is also used for a few surveys. The metric practice guide being considered for approval by the American Congress on Surveying and Mapping 1/ recommends that after conversion the fundamental units for surveying should be the meter and decimals of a meter. It would appear that there would not be any significant benefit

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1/An organization of about 6,500 control surveyors, land surveyors, and mapmakers which was formed primarily to advance the science of surveying and mapping and establish a central source of reference and union for its members.

in converting to the metric system because the change would be primarily from the use of one unit to another. One unit is no more accurate than another. However, some benefit may result from a single, uniform system on a worldwide basis. It is also possible that the switch to the meter may eliminate the use of the rod and chain for future surveys. This should be of some benefit. However, if conversion occurs, they would continue to have to work with the customary system until all surveys are redone in metric since verification of old surveys is continually being done and will continue indefinitely.

A minor nuisance also would be eliminated if architects and surveyors were using the same system. Architects are using feet and inches while surveyors use feet and decimals of a foot. Some difficulty exists in changing inches to decimals of a foot and vice versa. An example is expressing their inches in tenths of a foot. A change to metric by both could eliminate the difference.

Conversion disadvantages would probably not be of a major significance. Some costs would be involved in purchasing metric measuring tapes and surveyors' chains. Electronic distance-measuring equipment is used by many surveyors. Many of these devices will indicate in both metric or customary with a slight mechanical change. If the equipment is not convertible, conversion would be more expensive. Some metric training would be required for office staff. Initially, surveyors may not have the "feel" for the metric system that they had developed for the customary system.

Although metric conversion was usually considered inevitable by the surveyors, surveying will probably not be predominantly metric until it is mandatory or the surveyors' clients request surveys in metric.

The year 1983 has been proposed by some proponents of a change to metric as a possible conversion date for surveyors because at that time the State Plane Coordinate System 1/ will be readjusted to conform with new longitude and latitude lines

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1/The State Plane Coordinate System was developed by the Ocean Survey so that the curvature of the earth would not have to be taken into account when performing local surveying and mapping. Each State is broken down into one or more zones, depending on the size of the State. These zones are based on a system of longitude and latitude coordinates. A surveyor or mapper can work with the coordinates within a zone and not have a scale distortion due to the curve of the earth that would exceed one part in 10,000.

for North America. The system will also be in both customary and metric dimensions for the first time. Many States have passed legislation adopting the State Plane Coordinates as their reference system. These States may have to change their legislation in order to use the metric dimensions for the system.

THE GO FORTH APPROACH

Many involved in surveying and mapping thought that the go forth approach, if practical, should be used to implement metric conversion. This means that existing surveys and deeds and plots would not be converted until property is resold or there is a need for the survey to be redone. This approach could be used to some degree in mapping. Maps would be metricated when they are normally revised and new ones are prepared. Otherwise, converting all the thousands of existing deeds, plots, and maps would be costly. An exception to this policy could be aeronautical charts, as discussed earlier in this chapter. Road map producers may want to give distances in metric on their maps when road signs are changed to metric.

The major drawback of the go forth approach is that it would take many years, possibly decades in some cases, before conversion would be completed. Some confusion may result, for example, when metric maps are used together with customary maps.

HARD AND SOFT CONVERSION

If conversion takes place, old parcels of land, when resurveyed, would have measurements expressed in metric units, but the actual distances would not change--a soft conversion. New divisions of land for housing developments and so forth, however, could be set out in round metric numbers (hard converted). Roads are often 1 chain, or 66 feet wide, including the total right-of-way. New roads might be 20 or 25 meters wide. This is a hard conversion and would have an impact on culvert sizes and other related measurements, such as water runoff. Certain State and local codes may have to be changed.

Nautical charts probably would be hard converted. The direct conversion of fathoms and feet would yield awkward numbers. It would be necessary to go back to the data base of depth soundings and select round metric numbers. Contours on topographic maps also probably would not be soft converted.

POTENTIAL PROBLEM WITH SI UNITS

The 360-degree circle and degrees, minutes, and seconds of arc are widely used throughout the world for longitude and

latitude. The nautical mile is also part of this system. Some concerns have been expressed that the SI units--the kilometer and the radian--are not adequate replacements for the degree, minute, and second of arc and the nautical mile. No comparable system exists in the metric system. The Assistant Secretary of Commerce for Science and Technology in interpreting and modifying the SI system for U.S. use (see ch. 2) lists the degree, minute, and second of arc as units acceptable for use with the SI metric system and the nautical mile as acceptable for a limited time subject to further review. The International Committee for Weights and Measures of the General Conference on Weights and Measures has also agreed to the degree, minute, and second and has temporarily sanctioned the use of the nautical mile. An NBS official said that the nautical mile would probably be used for many years.

CONCLUSIONS

If conversion to a predominant use of the metric system occurs, surveyors and mappers would benefit somewhat from a single, uniform measurement system on a worldwide basis. Surveyors and mappers would also benefit to a degree in that some of the basic data is already metric and the cost and time required to convert this data to customary units would be eliminated. In both cases, surveyors and mappers generally considered these benefits to be insignificant.

Some conversion costs would be involved for surveyors and mappers, but no major problem was anticipated as long as the go forth approach of converting is followed. Such an approach may not be completely possible with aeronautical charts. If these charts are converted as they are normally updated or new ones are prepared, pilots may be faced with having to deal with both metric and customary charts for many years. This could increase the chance for error and accidents. The alternative to this type of conversion is a more costly effort to convert aeronautical charts in use as soon as possible.

If a decision is made to convert, a conversion target date would be needed to allow the mapmakers to plan for conversion of the charts.

In the absence of mandatory conversion, surveyors and mappers generally would not convert to a predominant use of the metric system unless metric surveys and maps are demanded by their clients or customers. Aeronautical charts probably would not be converted unless specified by the International Civil Aviation Organization and the Interagency Cartographic Committee which includes the Federal Aviation Administration. Road maps would probably not be converted until road signs and odometers are converted. Conversion of recreation maps

depends on acceptance by the general public. Construction surveys and maps would most likely be in metric when the construction industry converts.

CHAPTER 21

FOR WORKERS, SOME TRAINING AND METRIC TOOLS

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Almost every worker would be affected to some extent if the United States were to convert to the metric system. Although the full impact is not known and probably would not be known until conversion occurs to a greater degree, the major potential issues appear to be metric training and tools for employees. Workers, to varying extents, would need to learn a new measurement language, and some workers would require metric tools. Worker productivity may also be affected.

At this time, relatively few workers have been affected by metrication. Thus, what their reaction to metrication would be is unknown.

We discussed metric conversion with officials of the United Auto Workers, the Teamsters Union, and the American Federation of Labor and Congress of Industrial Organizations (AFL-CIO). The latter has 105 affiliated unions with a total membership of about 14 million. The Teamsters and United Auto Workers have a membership of 2.2 million and 1.5 million, respectively. About 20 million workers, or 22 percent of the U.S. labor force, belong to a labor union. We also discussed metric conversion's impact on employees with representatives of numerous industry firms and organizations.

METRIC TRAINING

Many industry representatives indicated that metric training for employees would be time consuming and costly. To reduce these costs, various metrication advocates and industry representatives believe that employees should be familiarized with the metric system on a need-to-know basis. That is, they would only be taught what is required for them to perform their jobs, and individual employees would receive metric training only if it were needed.

The AFL-CIO finds this approach unacceptable. It considers this approach an attempt to minimize short-term costs but which may result in eventually limiting the ability and flexibility of the work force. It's concerned that workers could be locked into their jobs, and it believes the approach would narrow and depersonalize the workers. Its position is that knowledge of metric measurement could, but should not, be a consideration in awarding jobs and that consideration should be given to older workers who might have a more difficult time learning the system and consequently may show deterioration in job performance compared to younger workers.

The AFL-CIO has called for special metric training programs to be established. It believes these should be continuing, flexible, and designed to assure the workers' continued full participation in the work force with no diminishing of future opportunities. Furthermore, the AFL-CIO believes that union apprenticeship and training committees should be involved in planning and developing metric training programs.

Our work showed that a relatively small number of workers have been affected by metrication and only to a limited extent. In those firms where metric training has been provided, the approach of familiarizing employees on a need-to-know basis has generally been followed with no apparent objection by employees. This, however, may be due to the fact that relatively few workers have been affected by metrication.

METRIC TOOLS

If metric conversion takes place, some workers would need metric tools. In addition, some workers may require two sets of tools, one metric and one customary, because they could be dealing with both metric and customary equipment during the transition period. However, some tools are not measurement sensitive. These would not have to be replaced.

In some cases, workers' tools are provided by the employer. In other cases, workers must purchase their own tools. In the latter case, if the tools are necessary to perform their jobs, they may be tax deductible. The workers, however, would incur some costs in purchasing metric tools.

Labor union officials told us that the workers should not bear any metrication costs. They have indicated that the cost of metric tools should be borne by the employer or the Federal Government. Industry and union representatives said that the need for metric tools has not yet become a major area of concern.

Those firms that are metricating often are providing their employees with at least part of the metric tools required, such as the auto industry. Some firms, as a matter of policy, provide employees with necessary tools, customary or metric. The United Auto Workers has made an agreement with General Motors, Chrysler Corporation, Ford Motor Company, and American Motors Corporation whereby the firms make available necessary metric tools or calibrated measuring instruments from company tool cribs on a checkout basis for the short or long term. Apprentices also receive an allowance for metric tools. Presently, skilled trade employees must provide their own customary tools.

Union officials told us that their members have not complained about this arrangement but that only a small number have needed metric tools. The officials said that the tool crib arrangement may not be suitable as more members need metric tools. They further stated that metric tools may become a subject of future negotiations with the auto firms.

The Canadian Government, in March 1977, established a 5-year assistance program for metric tools estimated to cost $40 million. The program is aimed at employees who are required to provide their own measurement-sensitive tools for the performance of their duties. Eligible employees will be able to be reimbursed by the Government for 50 percent of the cost of new metric tools that duplicate their customary tools because of metric conversion. This program does not apply to self-employed persons or those who are provided tools by their employers. The program is effective from April 1, 1977, and is to terminate on March 31, 1982.

Union officials have stated that another potential metrication issue is workers' personal tools. Some workers have tools that are not a condition of employment but are carried as a personal convenience to expedite their work. Some of these tools may have to be replaced but may not be covered under a program such as Canada's.

WORKER PRODUCTIVITY

Some labor union and industry officials have expressed concern that metrication would result in decreased productivity. Until workers are familiar with metrics, they may work more slowly, less surely, and therefore be less productive. The AFL-CIO believes that workers under piecework and other wage incentives provisions may have a reduction in income because of lowered productivity while the industry is converting and the worker is learning a new measurement system.

Several industry representatives anticipated errors by workers because of unfamiliarity with metric. Productivity could also decrease because the time required for metric training would be time away from normal duties.

OTHER LABOR CONCERNS

The AFL-CIO has also expressed concern that metric conversion could have an adverse impact on worker income and job security. The union believes that large conversion costs; employee confusion; shortage and scheduling problems; increased imports; equipment adjustments; and difficulty in interfacing, mounting, and connecting metric and customary equipment could increase unemployment and temporary layoffs.

The AFL-CIO is also concerned about its members as taxpayers and consumers. It views metrication as an expensive burden on the U.S. taxpayer. Conversion costs, according to the AFL-CIO, would be hidden in the price of products, taxes, and inflationary pressure. The AFL-CIO believes that consumers who weren't familiar with the metric system would be confused and could be exploited by merchants and producers.

CHAPTER 22

SPORADIC ACTIONS BY THE FEDERAL GOVERNMENT

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SPORADIC ACTIONS BY THE FEDERAL GOVERNMENT

Metrication activities of Federal agencies vary widely with no consistent approach to them. A few more than half of the 26 Federal agencies we contacted had or were developing a policy on metrication. Several had or were developing specific plans to convert. A Federal interagency subcommittee has been working on exchanging information on common problems since 1975, but its members are not at a high enough level to be effective. A higher level interagency committee has been designated, but it has not met as of February 1978. Federal agencies need to improve coordination efforts within the Federal community as well as between themselves and the private sector.

Some agencies have been proceeding on their own and, in effect, advocating metrication, such as the Federal Highway Administration (see ch. 10), the National Weather Service (see ch. 28), and the Department of Agriculture and the National Bureau of Standards, which are discussed in this chapter. These individual actions seem to be inconsistent with the intent of the Metric Conversion Act of 1975.

Federal agencies do not agree on the intent of the Metric Conversion Act. Some believe metrication is mandatory for Federal agencies, and others say it is voluntary. We believe the Congress intended that the Federal Government, through the mechanism of the U.S. Metric Board, act as a planning and coordinating focal point for voluntary conversion to the metric system without a time frame for the conversion. The act contains no requirement for compulsory conversion to the metric system and specifies that the decision to convert is voluntary.

Guidance from the U.S. Metric Board may help Federal agencies focus on their roles, but the Metric Board has no authority to require them to take action. Moreover, the Office of Management and Budget needs to instruct Federal agencies that conversion is to be a voluntary decision made by the private sector and not by Federal agencies.

Federal agencies have not determined what it would cost to convert their operations. Officials expect that the Government will gain no special benefits from metrication; however, it is generally believed that if U.S. industry benefited, the Government would benefit. Agencies, such as the Department of Defense and the General Services Administration, do not intend to use their purchasing power to foster

metrication. Instead, they intend to wait for U.S. industry to provide metric products.

If the United States were to convert, a vast array of laws, regulations, and other requirements would have to be reviewed to ascertain the impact and type of change. The Federal agencies have not determined the extent and impact of metrication in this area. Some agencies are considering such studies. Because the Metric Conversion Act did not affect existing law, we believe there is no need for Federal agencies to pursue metricating existing laws, regulations, or other requirements until the private sector requests such a change or an agency can demonstrate that the change is in the Nation's best interest.

FEW POLICIES BY FEDERAL AGENCIES

The Metric Conversion Act of 1975 does not define the role of Federal agencies in metrication. Only the U.S. Metric Board is specifically assigned responsibilities under the act. The Board is not to advocate metrication but is to assist the various sectors when, and if, they choose to convert.

As of November 1977, 12 of the 26 Federal departments or agencies we contacted had formal policies on metrication, and 3 others were developing a policy. Eleven others had no policy and were not developing a policy. Some officials said their agencies were waiting for the appointment and actions of the Metric Board before developing a policy, and others said the heads of their agencies lacked interest in a metric policy. In several instances, agency suborganizations have developed a metric policy and conversion plans without the agency establishing a policy.

We could not identify any benefit, advantage, or disadvantage of conversion which applies only to the Federal Government. Thus, the need for a policy may not be of specific importance to an agency.

Many agency officials expressed a view that the Metric Conversion Act of 1975 was vague on what the agencies should be doing. Some suggest that an Executive order by the President clarifying the position of the executive branch would be helpful. Others said that the Congress should clarify its intent on conversion.

Possibly the U.S. Metric Board will be able to provide direction for the Federal Government. However, the Congress did not intend for the Federal Government to encourage, advocate, or compel conversion, and the Metric Board was not provided with any compulsory powers.

The Office of Management and Budget is charged with the responsibility of developing Federal coordinating mechanisms and expanding interagency cooperation; therefore, it should be providing guidance to Federal agencies on metrication. An Office official said the agency had not done so because it was awaiting the formation of the U.S. Metric Board.

FEDERAL COORDINATION SPARSE

Interagency coordination on metric conversion is struggling into existence. In June 1975 the Interagency Committee on Standards Policy, which is chaired by the Department of Commerce, formed a subcommittee on metrication, known as the Metrication Subcommittee. The Metrication Subcommittee's purpose was to exchange information on common problems related to metrication.

Initially, participation in the Metrication Subcommittee was limited to about 10 agencies. Later, 48 other agencies were invited to participate. Most agencies have designated a representative, and 42 agencies are listed as participating. In February 1976, 16 panels were organized whereby agencies with common concerns and responsibilities could share metric information.

In early 1977 the 16 metric panels were dissolved in favor of 8 divisions which covered transportation, construction, procurement and supply, legislation and regulations, fuel and power, metric practices and preferred units, consumer affairs, and awareness training and education. Each division will develop a metrication plan, remain cognizant of national trends, coordinate Federal activity, and disseminate information on metric activity. These divisions were still in the formative stages as of February 1978.

Also, in early 1977 the Metrication Subcommittee's chairman established an executive board because frequent meetings of the entire membership were too difficult to manage. The executive board, which meets about monthly, has initiated most projects undertaken by the Metrication Subcommittee.

The Metrication Subcommittee meets irregularly and has held only nine meetings since inception which covered primarily organization and metrication activities of agencies. Some members have complained that not all agencies were participating in their activities which, in their opinion, restricts the Metrication Subcommittee's effectiveness. Another complaint was that the membership is comprised of personnel from too low a level to have any impact on their agency's policies. The members are mid-level managers for the most part.

In June 1977 the Metrication Subcommittee approved a model metric policy as a guide for agencies to use in establishing their policies; however, the Interagency Committee on Standards Policy has not approved the model as of November 1977. The model points out that industry is expected to take the lead in conversion. Further, agencies should be capable of assisting conversion in those areas which the agencies have an appropriate leadership role. Overall, the model points out that it is considered in the best interest of the agencies to pursue a consistent and uniform approach to conversion. Whether agencies will utilize this model policy is not known. Only a handful of agencies have metric policies, and most of these were written before development of the model policy.

The Metrication Subcommittee has continuously been concerned with its role and position. In June 1976 it recommended establishing a separate interagency committee on metric policy. A draft charter was prepared, approved by the Interagency Committee on Standards Policy, and submitted to the Secretary of Commerce. After considering alternatives of who should establish and head such a committee, the Secretary of Commerce in August 1977 polled 45 Federal departments and agencies on the need to establish a high-level, interagency, policy committee on metrication. The Secretary suggested that the new committee should be established under the Department of Commerce, and the Assistant Secretary for Science and Technology would be the chairman. Essentially, agencies indicated that a separate high-level, interagency committee should be established. Concern was expressed that the position requirements for participants were too high for smaller agencies. As of February 1978 about 30 agencies had designated their representatives for this committee, but no meetings have been held.

Several Metrication Subcommittee members believe that the Metric Conversion Act says that metric conversion is mandatory for Federal agencies. However, not all agency members agree. Our interpretation of the act is that conversion is voluntary, even for Federal agencies. If any agency believes that it is in its best interest to use the metric system of measurement in its operations, existing legal authorities may allow this. The Metric Conversion Act of 1975 does not alter any existing laws, and authority for change would be based on existing law or amendments sought.

If the United States is to convert to the metric system, an interagency policymaking committee will be helpful to allow a consistent Federal approach to conversion. The time it has taken to establish such a committee suggests a lack of urgency felt by most agencies, the vagueness of the Federal

agency role in metrication, and the voluntary nature of the Metric Conversion Act of 1975.

DEPARTMENT OF AGRICULTURE

Agriculture has opted to convert expeditiously at a minimum cost and with minimum disruption to ongoing programs. Agriculture recognized that it must follow industries' lead except in those areas where the leadership role is in its own best interests. Its conversion activities have been mostly internal to date and it has progressed further than most other Federal agencies.

In August 1977 the Secretary made the Director of Economics, Policy Analysis and Budget responsible for

--coordination of Agriculture actions in this area,

--issuance of such additional instructions as may be necessary for the guidance of Agriculture agencies,

--preparation of such reports as may be required by law or regulation,

--representation of Agriculture with other governmental or private organizations, and

--appointment of a Metric Coordinator and other staff as necessary to carry out these responsibilities.

In September 1977 administrative regulations were issued implementing Agriculture's approach to metrication and were based on the interagency Metrication Subcommittee's model policy. These regulations essentially require the use of metric terminology wherever practical in Agriculture's operations. The regulations call for using the metric system except when metric equipment is not available, the cost of metrication is significant, metrication would adversely affect scheduling, and metric use is not deemed in Agriculture's best interest.

Conversion mandatory for the Department of Agriculture

While Agriculture recognizes that conversion in the private sector is voluntary, it believes that conversion is mandatory for Federal agencies and particularly for itself. The national policy is to plan and coordinate the increasing use of the metric system, and this means the Federal agencies must convert, according to an Agriculture official. He told us that the Government must set the example if the public is to take metrication seriously. Agriculture's mission is to

metricate internal operations and to help, not push, the public toward metrication.

In October 1977 Agriculture reported to the Senate Appropriations Committee on its metrication activities. In this report, Agriculture said that the word "voluntary" in the Metric Conversion Act of 1975 was conceived by many to mean that no conversion was necessary, and this greatly slows the establishment of a national consensus on metrication. Agriculture said that there is a need for stronger direction on metrication so groups can be brought together to solve problems.

Agriculture also reported to the Committee that the interagency Metrication Subcommittee had determined that metric conversion was mandatory for Government. This Subcommittee had never made such a determination. Subsequent to Agriculture's report, the Metrication Subcommittee entertained making such a determination. However, it determined that the Metric Conversion Act of 1975 meant that Federal agencies shall plan and coordinate increasing metrication, and one of the ways of accomplishing the objective is through each agency converting its own activities.

The Department of Agriculture is leading the way in selected areas

An Agriculture metric coordinator has been appointed and coordinators for suborganizations have been designated. Agriculture acknowledges that some actions by others must proceed before it can convert all its activities. For example, laws, regulations, and reporting habits of other Federal agencies must be changed as a prelude to Agriculture's conversion. However, most organizations within Agriculture have started metrication activities. According to an Agriculture official, the majority of conversions are soft, as will be most future conversions.

Below are some examples of conversion and planning activities within Agriculture. As can be seen from the following information provided by Agriculture, those organizations involved with science and international trade are moving more rapidly than the more domestic or less scientific areas. However, some domestic programs are being converted.

Research and education

--Agricultural Research and Cooperative State Research Services were largely converted several years ago. Further conversion is being studied.

--Extension Service is an educational organization with the farmer as the target. Metric publishing is underway for articles and handbooks from several schools. Home publications and slide sets are being planned in metric. National 4-H materials will have dual units and will have metric teaching guides. Universities are being encouraged to use metric in all Extension publications and releases.

--The Foreign Agricultural Service changed all reporting and information programs to metric units in 1976.

--The Economic Research Service has changed to reporting all foreign data in metric units. The practice of showing dual dimensions was phased out in 1977. Ocean freight information now is metric. Most long-range projections will now be published in metric units or accompanied by metric conversion factors.

--The Farmer Cooperative Service says that all future international trade statistics will be in metric units. Publications on commodities which are internationally traded are to be metric or show dual units.

Farm programs and land use

--Agricultural Stabilization and Conservation Service says that metric units are used in purchases for the Food for Peace program. A study is underway to use the metric system on 1978 crop programs subject to legislative restrictions. Domestic food programs will be metric. Land area allotments for crop plantings will be in metric terms, and price support computations will be determined using metric terms.

--Food Safety and Quality Service now is using dual specifications for ground beef for school lunches. Some farm bulk-milk storage tanks reports are in metric units. Annual seed price tables are metric. New grade standards for fruits and vegetables will include metric units.

--Animal and Plant Health Inspection has accomplished substantial amounts of conversions. A hearing for using metric units for labeling in Federal Meat and Poultry Inspection Programs was conducted. The 1978 title 9 of the Code of Federal Regulations--Animals and Animal Products--is dual while the 1979 version is to be metric only.

In June 1977 the American Farm Bureau Federation, which is a federation of farm bureaus in 49 States and Puerto Rico, asked Agriculture to formulate a policy on conversion for the private agriculture sector. Also, the American National Metric Council has sought Agriculture's leadership in organizing the private farm sector's metric activities. However, Agriculture has declined these requests because its policy precludes its personnel from chairing meetings to convert the private sector, but allows participation in such meetings.

To help inform the public on the metric system, Agriculture is planning to print both customary and metric units in its most popular publications beginning in July 1978. About 15 publications will be affected, we were informed. Agriculture will not be converting its major domestic information programs or technical publications at that time. According to an official, Agriculture will wait for public reaction before converting additional programs or publications.

Public reaction

Most of Agriculture's activities in metrication have been internal thus far. In May 1977 Agriculture solicited comments from the public on a proposal to use metric units on labels for meat and poultry. Its notice in the "Federal Register" stated that because use of the metric system by the private sector is voluntary, neither regulatory action can be taken to require its use nor should action be taken to inhibit voluntary conversion by industry. The notice recognized the present limited use of the metric system in this country and suggested that a long period of limited or dual use may be necessary to acquaint the general public with the metric system. The notice pointed out that the labels of many food items, including meat and poultry products, already have dual weight declarations with customary units shown first and metric units in parentheses.

The public response was mostly negative. Only 25 percent of the responses could be construed to be favorable. About 63 percent were opposed to metrication, and the remaining 12 percent indicated basic opposition to metric usage but a willingness to accept dual-dimensioned labeling if metrication were necessary. However, according to an Agriculture official, Agriculture was not asking whether to convert, but how to implement the change to minimize consumer confusion.

Cost and timing of conversion

The cost of conversion is unknown at this time, according to an Agriculture official. No metrication cost study has

been conducted, and none are planned. Organizations are expected to absorb the costs in their budgets.

There is no sense of urgency for conversion, but the sooner the better was the opinion of Agriculture's metric coordinator. The pace of conversion will depend, to a great extent, on activities outside Agriculture. Agriculture estimated, however, that internally it could be converted within 5 years.

Anticipated problems

Laws and regulations, as well as reporting requirements, of various other agencies may cause problems. An official particularly identified the inspection and grading system and the packaging and labeling requirements as potential problem areas. The United States Code and the Code of Federal Regulations also have numerous sections making reference to customary units. Each Agriculture organization has been instructed to study these problems while developing timetables for conversion.

According to an official, when Agriculture requests metric information from the farmers, only that information will have to be in metric units. Farmers will not have to metricate their whole operations.

DEPARTMENT OF COMMERCE

The Secretary of Commerce has the responsibility of interpreting and modifying the International System of Units for use in the United States. Also, NBS, an agency of the Commerce, conducted a study of the use of the metric system and issued the 1971 report, "A Metric America, A Decision Whose Time Has Come," which is discussed in chapter 1. Accordingly, some groups perceive Commerce to be the Government's lead agency for metrication. Overall, however, relatively little metric activity has taken place at Commerce; most activity is concentrated in a few of its agencies--the National Weather Service, NBS, and the Patent and Trademark Office. Commerce has not published an overall metric policy. However, it has produced a handbook for U.S. exporters on metric laws and practices in international trade.

NBS

NBS is the Nation's caretaker for measurement standards. It maintains a complete and consistent system of physical measurement for reliable reference. Its overall goal is to strengthen and promote the Nation's science and technology for the public's benefit.

Since 1974 NBS metric policy has been to encourage and lead national usage of the metric system. Its internal guidelines call for NBS publications to use metric terms except in those instances where the reader would not be familiar with the terms. However, its personnel are encouraged to familiarize readers with the metric terms to promote public understanding and encourage people to think in metric terms. The guidelines state that the transition period to the predominant use of the metric system is not sharply defined, and NBS leadership in the national transition will be more effective if the transition within NBS is as complete and as rapid as possible.

The principal metric activities at NBS include providing information to the public and supporting activities of organizations, such as the American National Metric Council and the National Conference on Weights and Measures. Additional NBS metrication activities are discussed throughout this report.

The Patent and Trademark Office

In July 1974 the Commissioner of Patents issued a notice stating that patent applicants are strongly encouraged to use either SI units only or dual units when describing their inventions. The notice said that metric use was not mandatory at that time, but the request was made as part of a long-range program for conversion being conducted by the Federal Government.

Further, metrication activity within the Patent Office was given impetus by the Patent Cooperation Treaty of 1970. This treaty, signed by 35 countries and ratified by the United States in 1975, offers improved international protection of inventions. It calls for the use of metric units in application for international patents. According to a Patent Office official, the requirements of this Treaty will not create any great problems for the Office. Of the some 100,000 annual patent applications handled by the Office, only 12,000 would come under this treaty.

Although the treaty calls for the use of metric units, it does not specify that they be SI metric units. Also, it requires temperature to be recorded in centigrade rather than Celsius, the SI term.

The treaty also calls for international patent submissions to be on a specific metric size paper referred to as the A4 size. This paper size is larger than the normal U.S. letter size. (See ch. 19.) The treaty allows each country to receive initial applications on any size paper but requires

the above sized paper for applications transmitted to the international patent organization.

A Patent Office official told us that they expect the metric paper size will be available from commercial sources or the General Services Administration. However, the Office has not pursued this to any great extent.

The Office will reproduce applications on the international size paper for a fee. However, because most patents are processed through attorneys specializing in these applications, the Office expects the transition to the new paper size to be smooth.

DEPARTMENT OF DEFENSE

The Department of Defense has a formal metrication policy directive, dated December 10, 1976, which favors an increased use of metric units and metric products for Defense and the individual services. The impact this directive will have on actual Defense metrication is difficult to predict at this time. The policy allows a wide latitude of judgment and discretion in decisions on whether or not to go metric on a particular project. Much will depend on the individual project managers who must justify the use or non-use of the metric system in their particular projects.

Defense has used metric measurements in selected activities for many years. These activities in the past centered around improving interchangeability of parts and supplies and commonality of operating procedures, particularly with our allies. These activities have led to metric-dimensioned artillery and small-arms ammunition and tactical maps.

Defense has recently taken a few tentative steps toward greater use of the metric system. There are several current projects which involve the use of metric units in design and production. These projects are mainly hybrid--a combination of metric and customary components.

Defense's December 10, 1976, metric policy states that many Defense-related industries have converted or are planning conversion, and Defense must be in a position to accept this conversion with minimum cost and disruption of operations. It further states that industry will generally lead the conversion process, and Defense will follow whenever it is technically and economically practicable. It requires in the review of projects that the use/non-use of metric units of measurement be addressed and additional justification be submitted if metric usage is not specified. According to an

official, the suitability of metrication must be judged on a project basis because each project has unique features.

A Defense official informed us that there is nothing in the Metric Conversion Act of 1975 which would disallow or constrain Defense from taking a leading role in the conversion process. However, the current directive emphasizes a strategy of following industry.

Defense looks to metrication to help foster standardization with our allies to "promote interchangeability and interoperability, facilitate joint military production programs, and simplify supply operations." Finally, it considers metric usage especially appropriate in the design of new equipment.

Comments from officials in the individual services mirror the Defense stance on not leading the conversion process but staying in step with industry. They want to avoid moving too fast.

Varying degrees of metric activity

Although the extent of metric activity varies with the services and individual projects, metrication at Defense consists essentially of coordinating and planning with relatively few actual metric projects.

In the area of coordination and planning, Defense established a metrication panel in 1974 consisting of the armed services and selected Defense organizations to develop a recommended approach for the conversion of specifications and standards. Defense also maintains memberships in a number of private sector groups involved in metrication, such as ANMC, Society of Automotive Engineers, and the Aerospace Industries Association. It maintains liaison with other Government agencies through the Metrication Subcommittee of the Interagency Committee on Standards Policy. Each service has its own metric coordinator who acts as a focal point for metric information.

Standards development

One metric activity in which Defense is engaged is the development of metric engineering standards suitable for Defense projects. Activities in this area include preparing a guide for using metrics in standards, processing a military specification on the general requirements for metric machinery and developing a standard on the use of metrics in new designs. In addition, Defense, in cooperation with ANMC, is developing a computer-aided system to trail the conversion

of some high priority standards. Defense would prefer to reduce its involvement in standards writing and rely more on the private sector, but it will continue to be involved in some standards development. Standards are discussed in more detail in chapter 6.

Army

The Army has used metrics in mapping as early as 1947, and since 1961 the Army's artillery school had revised all of its lesson plans used in field artillery courses to reflect metric changes.

The Army is currently working on a long-range metric plan which is much broader in scope than just specifications and standards. It also hired a consultant to "get the pulse" of industry, obtain information on foreign experiences, and develop a proposal for a long range plan for Army conversion. Plans and projected budgets are also being prepared for the metrication of specifications and standards.

The Army has a number of metric projects involving missiles and rockets. The Missile Command solicited bids for a new lightweight rocket launcher and specified that the system be designed, built, and documented using metric units. A contract has been awarded for the helicopter-mounted Hellfire missile with the instruction that all new components and systems be designed in metric units.

The third and most involved project is the Roland surface-to-air missile. Its basic design was developed jointly by France and Germany and sold to the United States for domestic production. It is an example of U.S. willingness to increase standardization of equipment with its North Atlantic Treaty Organization (NATO) allies. According to the manufacturer, they have encountered developmental problems stemming mostly from language translation and noncompatible engineering practices rather than from measurement units used. The problem is standardization, not metrication.

Air Force

The Air Force reported no metric projects. However, it is requiring, by regulation, that its buying agencies outline the impact of metrication on their purchases. A judgment will be made on the merits of metrication for each proposed purchase.

Navy

The major metric project for the Navy is the Patrol Hydrofoil Missileship. There are no other ships of metric design in production or on the drawing boards. Metrication for a new landing ship was considered but rejected. We were informed that other factors outweighed the metric-versus-customary issues.

The Hydrofoil is a hybrid project containing both metric and customary parts. Those items of metric design include: the physical description, performance characteristics, design drawings, fasteners, and all testing analyses except fluid power. Nonmetric items include off-the-shelf items, such as bilge pumps, compressors, and engines.

Fasteners for the Hydrofoil prototype were mostly German standard metric fasteners because they were readily available and U.S. metric fasteners were not readily available. The German standard fasteners were not adequate in all cases so the manufacturer developed some special metric fasteners and internal company engineering standards for the fasteners.

Standardization in NATO

The Department of Defense policy cites metrication as a way to help foster standardization with our allies. This is one way of increasing standardization and, as noted previously, has been used in tactical maps and in weapons and ammunition design. However, factors other than the measurement unit must be addressed before standardization can be achieved.

The problems of standardization within NATO are the result of a multiplicity of research development and production problems. It is generally acknowledged that political, economic, and social conditions often take priority over standardization efforts. 1/ Nonmilitary factors, such as inflation, unemployment, balance-of-payments, and the maintenance of a strong industrial capability, must be considered. Thus, in our opinion, even if the world was metric today, NATO would still have standardization problems.

In our January 1978 report on NATO standardization, we concluded that overcoming the impediments to greater standardization in NATO will require significant departures from present practices in acquiring weapon systems--the principal

1/"Standardization in NATO: Improving The Effectiveness and Economy of Mutual Defense Efforts," PSAD-78-2, Jan. 19, 1978.

impediment being the consideration of newly proposed systems in terms of national rather than international needs. Yet it is logical that if all countries are to agree to adopt common weapon systems for their militaries, economic and political problems of each will have to be acknowledged and accommodated. Thus, standardization is not likely to be achieved without statesmen-like compromises.

Inventory

It is estimated that Defense has about 4 million different items in its inventory. According to officials, this number will be significantly increased during the transition phase of metrication, but the total should eventually decrease once the customary items are eased out of the system.

One of the major difficulties with the metrication of Defense inventories is the presence of existing customary items with long life cycles. An aircraft or tank can last 20 to 30 years. If new metric items are purchased, a dual inventory will have to be maintained until the customary items are removed from the inventory.

According to a Defense official, the private sector controls much of what goes into the Defense supply system and inventory. Except for military hardware, such as tanks, ships, and fighter aircraft, Defense seldom buys sufficient quantities of a product to control that market or tell the manufacturer what parts the product shall contain. Defense buys common items, such as light bulbs, electric fans, air conditioners, or automobiles, "off-the-shelf." That is, Defense buys what is commercially available.

According to Defense officials, the nature of these off-the-shelf items depends on decisions made in the private sector. The development of new metric standards and the introduction of new metric products will be the result of thousands of individual decisions in the private sector. If the private sector does not exercise constraint, proliferation of metric parts in the Defense supply system could result.

Costs

There have been no recent attempts to estimate the costs for metricating the Department of Defense. For the 1971 NBS metrication report, Defense estimated that its metrication would cost $18 billion. The conversion was envisioned to take place in 30 years, and 75 percent of the $18-billion price tag would accrue during the first 10 years.

No Defense official would attest to the validity and accuracy of the $18 billion estimate. Comments on this estimate ranged from "it may or may not be accurate," to "the subject is complex and we are not really confident of any cost estimates."

There was some agreement on the fact that while the 1971 estimate of $18 billion was a large sum of money, it was to be spread in varying amounts over a period of 30 years thus the effect on the annual budget would be minimal. For instance, the Army estimated a total 30-year metrication cost of $4.4 billion but pointed out in a report that even in the peak-cost years, the total increase would be less than 2 percent of the annual budget.

An Army followup study in 1973 emphasized that this $18 billion estimate assumed a conversion process where Defense was metricating in conjunction with a national conversion program. If, for some reason, Defense leads the conversion process, the costs will increase.

The Navy Metrication Group attempted to develop an overall funding profile for Navy metrication but met with no success. Some groups used the estimates prepared for the 1971 NBS report as their base figures and increased them to correct for present values. Others used the 1971 estimates as the base figures and then decreased them because of reports which indicate actual costs are seldom as high as anticipated, or projected, costs. And others indicated the situation was too fluid and uncertain to make a useful estimate. The Metrication Group abandoned its efforts for an overall estimate and has left it up to each functional area to estimate the costs in its own local budget process.

Estimating costs on individual projects is also difficult. One Defense spokesman said that estimates of increased costs due to metrication ranged from 6 to 18 percent. One project manager reported a range of 3 to 30 percent.

Defense and industry officials believe metrication will involve additional costs in Defense programs, but there is no consensus on exactly how much it will cost or how those costs should be apportioned. One major question is whether a particular metrication cost is a current expense to be charged directly to a current project or whether that expense might be a capital investment to be amortized, over a span of time, against many projects. Defense, of course, would opt for the latter to minimize current costs, and industry would choose the former to recover expenses as soon as possible.

Benefits

According to Defense officials, the benefits of a hard conversion are rationalization of parts and standards, standardization, and interchangeability. These goals are very important to Defense commitments, especially in our dealings with NATO. However, one Defense official said that he subscribed to the basic theory that metrication offered the opportunity to increase standardization and reduce costs but that these were ongoing programs within the Defense Department anyway. Metrication is not the sought-after end; it is a means to an end, but not an essential one.

DEPARTMENT OF ENERGY

The Department of Energy was established during the course of our review. According to an official, the Department has not yet formally appointed a metric coordinator. The metric coordinator of the Energy Research and Development Administration, which was absorbed into the Department, is acting in this position. He informed us that a policy on metrication is being prepared which is similar to the model policy of the interagency Metrication Subcommittee. However, he could not estimate when the policy would be completed.

DEPARTMENT OF THE INTERIOR

The Department of the Interior issued a manual in June 1975 which set forth its general policies and requirements for administering its metric conversion program. The policy statement pointed out the need for Interior to recognize that the country is converting to the metric system and to respond to this change. The policy assumed that the country would be operating in an essentially metric environment within 5 years; that is, by 1980.

While the 1975 policy called for a departmental metric coordinator and a metric coordinator for each suborganization, these coordinators neither met as a group nor recorded minutes or memoranda of discussions.

Interior revised its metrication policy in January 1978. The new policy establishes a metric conversion committee. The committee is comprised of a metric conversion officer from each of the suborganizations and is chaired by a departmental metric conversion officer. The revised policy deleted the reference to the 5-year time frame for conversion and was expanded to provide metric planning and detailed reporting. The new metric conversion committee held its first meeting in April 1978.

An Interior official characterized Interior's policy as positive on metrication. He said its policy will be to move ahead in planning for metrication.

Activities

According to an Interior official, metrication has not been a high-priority item, but there has been some metric activity within Interior and this has varied by organization. The Park Service shows both customary and metric units on some maps and speed limit signs in its parks. Also, it has marked some trails with dual dimensions. On the other hand, the Mining Enforcement and Safety Administration (now part of the Department of Labor) is very reluctant to move. It uses only customary units of measure and does not plan to convert until the mining industry is ready. The U.S. Geological Survey is planning to convert its maps (see ch. 20), and the Bureau of Reclamation has issued a metric practice guide. Also, the Bureau of Reclamation has required metric use in some construction contracts. (See ch. 16.)

Interior's metric coordinator participates in the interagency Metrication Subcommittee.

Legislation which is measurement sensitive, or contains many references to measurement, may pose some problems for Interior in its conversion. Some Interior organizations, such as the Bureau of Land Management and the Bureau of Reclamation, have their activities tied to laws which cite only customary units of measure. There has been no effort at Interior to identify the legislation or work on solutions.

According to an official, Interior is not approaching conversion from the standpoint of its own benefits--the benefits to Interior are tied to those of the Nation. If the Nation converts, Interior must convert. Interior's various offices and bureaus will have to allow for metrication costs in their normal programing and budgeting actions. No cost studies have been undertaken.

DEPARTMENT OF LABOR

Labor neither has a departmentwide metric policy nor any departmentwide metric activities planned or ongoing, according to an official. Labor does not perceive that it is under any pressure to convert, and one official foresees no advantage for labor in metrication. A metric coordinator has been designated for participating with the interagency Metrication Subcommittee. We identified one subagency--the Occupational Safety and Health Administration--where some metric activity

In January 1977 the Occupational Safety and Health Administration prepared a metric policy which called for soft conversions only. Under this policy, all its new or revised regulations would show the metric equivalents parenthetically behind the customary units, unless the measurement unit was already a metric unit. According to an official, nearly 90 percent of the units in the health regulations are already expressed in metric units. He did not know whether they are SI metric units. The policy, therefore, applies primarily to the safety regulations.

Soft conversion is the only type of conversion which the Occupational Safety and Health Administration could follow at this time, according to an official. Hard conversion would cause problems because products and materials described in rounded metric units are not necessarily available in the marketplace.

As of September 1977 the Occupational Safety and Health Administration had not published new or revised regulations incorporating the metric policy. Proposed regulations with soft conversions had been distributed for review and comment outside Government, and no negative reaction had been received, we were told.

The impetus for converting the regulations is the Occupational Safety and Health Administration's awareness of the U.S. movement to the metric system, we were informed, rather than any perceived advantages.

DEPARTMENT OF TRANSPORTATION

Transportation's policy is to pursue and promote an orderly changeover to the metric system. Its policy recognizes that the conversion will be evolutionary, and industry will set the pace for changeover. It will strive to tailor its conversion requirements and procedures to minimize cost to industries. Each organization within Transportation has been instructed to develop conversion guidelines in its area of responsibility and make them available to industry. (For more discussion on aviation activities, see ch. 15; highways, ch. 10; and water transport, ch. 10.)

DEPARTMENT OF STATE

Metrication, according to an official, is not a major issue at State because (1) the Metric Conversion Act prescribes no mandates, (2) governmental activity is being handled at a relatively low level--subcommittee of the Interagency Committee on Standards Policy, and (3) State perceives a lack of executive emphasis since the Metric board had not been

appointed and the President has not issued an Executive order on metrication.

The cost of conversion would be minimal and concentrated in education and training, according to a State official. It has people stationed worldwide; therefore, metric terms are not new to most personnel, the official said.

POSTAL SERVICE

The Postal Service considers itself to be in an awareness and preplanning stage. It has formed a metrication group and issued a policy statement. The policy restates the national policy of coordinating and planning the increasing use of the metric system on a voluntary basis. It calls for participation in Federal coordination activities, developing a plan for using the metric system, and implementing the plan in such a manner as to reflect a leadership role. The policy enunciates that a rule of reason will apply and that adoption of the metric system will occur on a schedule compatible with the voluntary conversion actions of its customers.

According to an official, conversion should be a hard conversion and it should be planned and scheduled. The Postal Service believes that it should be in step with industry's conversion and, while it is not opposed to conversion, believes that conversion should be orderly and timely.

Anticipated problems

Rates and regulations are based on weight and other measurements. For example, the postage rate for first class letters is 15 cents for the first ounce and 13 cents per ounce thereafter, and for fourth class mail (packages) the upper limits are 70 pounds and 100 inches of combined length plus girth. Conversion of these measurements to metric units would create some problems for the Postal Service and the public.

One area of concern to the Postal Service is the establishing metric base rates for mail. The current base weight for first-class mail is 1 ounce which is equal to about 28 grams. Thus, the problem lies in selecting a rounded base weight. Other countries use 20, 25, or 30 grams as the base weight for first-class mail. Canada has decided to use 30 grams. A spokesperson explained that the Postal Service is closely watching the Canadian experience to learn as much as possible.

The Postal Rate Commission, which is independent of the Postal Service, would have to recommend the metric base weight and any adjustment to the cost of postage, we were informed.

The Postal Service would then have the chore of informing the public of the new bases. A Service official told us that the conversion should occur on a specific date--similar to a postal rate change.

Another problem, for both the Postal Service and the public, will be acquiring metric scales or in converting existing scales to show metric weights. Nearly one-half of the Postal Service's customers weigh their own mail.

The Postal Service has some 240,000 postal scales of various types. As mentioned in chapter 9, scales can be modified or converted to show metric weights. The Postal Service does not have an estimate on the cost of scale conversion but is considering a study.

Besides the Postal Service's scales, postage scales used by businesses and institutions would also have to be converted. The Postal Service does not have any means to estimate the cost to its customers to make the conversion.

The Postal Service has obtained estimates of the cost to convert similar scales from the Canadian postal service. For example, the cost to convert a Parcel Post Beam scale ranges from $80 to $125. However, the Postal Service did not know how many scales of this type are in use. An inventory of the various types of scales used was in process.

GENERAL SERVICES ADMINISTRATION

The General Services Administration is the landlord, department store, and supplier for the Federal Government. That is, it supervises construction, operates and maintains most of the Federal buildings, and purchases and stocks much of the materials used by Federal agencies.

Although General Services does not have a formal metrication policy, a November 1976 internal policy statement says that (1) it endorses conversion but will not lead and (2) it will comply with the Metric Conversion Act of 1975 and work closely with the U.S. Metric Board, private industry, and the Federal interagency committee on metrication. General Services will not use its purchasing power to encourage conversion, because to do so would conflict with the policy to follow industry.

According to a General Services official, the Metric Conversion Act does not provide direction to the Federal agencies on what they should be doing. If the U.S. Metric Board gets going, or an Executive order is issued delineating the role of the Federal Government, then General Services may become more active in metrication, we were told.

Metric activity at General Services has been limited. A metric task force was established in 1975 and met quarterly until 1977, when these meetings were replaced with occasional telephone calls. General Services Federal Supply Service's metric group met monthly until 1977, but no longer meets. Its Public Building Service position is to follow the construction industry. (See ch. 16.) In 1976 General Services produced a metric awareness film, but interest in metrics has waned, and the film has been viewed by very few people.

We were told General Services participates as an observer on the interagency Metrication Subcommittee which is trying to set the direction of the Federal Government.

Cost of going metric

General Services has conducted no studies on the cost of going metric because, according to an official, there are too many variables beyond its control. One important variable is the nature and timing of industry's conversion.

An official did not believe there would be any added cost to buy metric items if they are available. For example, General Services has routinely bought metric laboratory glassware for Federal agencies, and this glassware is readily available. Also, since 1975 metric hand tools have been listed in General Services' Federal Supply Catalog. These tools are commercially available items and during the last fiscal year, General Services bought $180,000 worth of these tools.

The average cost to add a new item--metric or customary--to General Services' inventory is about $4,200 if the item is commercially available. If a Federal specification must be written, the cost is increased by about $3,500.

Disadvantages/advantages

A General Services official cited several problems from metric conversion, such as the need to carry dual inventories during the transition period, conduct training programs, adjust records and regulations, and replace some tools. General Services recognized these activities would cost something, but it did not know how much. Another problem would be in converting the Federal specifications to metric units.

Of the 4,500 Federal specifications, some 1,200 to 1,300 already have hard metric references. The official said General Services prefers not to show dual units or soft convert the specifications. Metric units will be added to the Federal specifications, if appropriate, during the regular updating. No timetable exists for converting any specifications.

The only advantage of metrication seen by the official is the possible eventual reduction of inventory and the reduction of duplicative manufacturing standards which may lead to reduced cost of operations.

ENVIRONMENTAL PROTECTION AGENCY

The Agency did not have a metric policy on conversion as of April 1977. However, in January 1973 a memorandum, signed by the Deputy Administrator to the managerial levels instructed the Agency to use metric units in standards, reports, and other documents it issued. Equivalent units were to be allowed whenever desireable in parentheses. However, an official doubted that many personnel are aware of this memorandum.

Measurement units used by the Environmental Protection Agency are a mixed bag. For example, some pollutants are measured in metric units (grams), but pipe sizes, construction measurements, and water metering are in customary units (inches, feet, and gallons). For automobile emmissions, pollutants are measured in grams per mile.

The Agency is faced with the scientific- and the general-use dilemma. Scientists use the metric system while U.S. industry traditionally uses customary measures. For scientific and technical publications, the Agency's manual requires all units used to be in SI terms, unless specified otherwise by the project officer. The manual order is dated May 1974.

Essentially, the Agency prefers metric use whenever possible, according to an official. In the scientific and technical area, Agency personnel are highly trained and work with SI units a great deal. In the engineering areas, the situation is mixed. For example, sanitary engineers work with the construction industry and consequently do not use metric units to any great extent.

According to an official, the Agency has no directions as to what it is supposed to do about metrication, and metrication is of low priority. The Agency would be in a better position to tell industry what the requirements are if it had some guidance from the President or the Congress. The Agency performs better under mandates than under a voluntary system, in the opinion of an official.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

According to an official, the National Aeronautics and Space Administration has not developed a formal policy, although a proposed policy has been in process for more than a

year. In essence, its position is generally to keep pace with industry and the Department of Defense.

According to officials, soft conversion would take from 1 to 5 years. Hard conversion would depend almost entirely on suppliers with the National Aeronautics and Space Administration able to do little more than an occasional prodding, but it believed it could not push too hard because this may result in higher costs.

According to officials, the scientific groups use metric units while the operating groups use customary units. A September 1970 National Aeronautics and Space Administration directive generally requires SI metric units to be used in its scientific and technical publications.

The National Aeronautics and Space Administration has designated a person as the metric focal point, and each of its 10 centers have a metric coordinator. Also, it has personnel participating on the interagency Metrication Subcommittee. No estimates have been made of the cost of conversion.

With one exception, the National Aeronautics and Space Administration has not been involved with projects with metrically designed hardware. The space shuttle now being tested was built to customary standards. The one exception was docking of the nonmetric American spaceship, Apollo, with the metric Russian spaceship, Soyuz, in 1975. The hookup was made possible by a connecting device built by a U.S. aerospace firm. One end of the U.S. device was built to metric specifications to permit hookup with the Soyuz.

CIVIL AERONAUTICS BOARD

The Civil Aeronautics Board promotes and regulates the civil air transport industry within the United States and between the United States and foreign countries. It grants licenses to provide air transport services and approves or disapproves proposed rates and fares and proposed agreements and corporate relationships involving air carriers.

The Civil Aeronautics Board has converted data to metric units for a number of years in its reports to the International Civil Aviation Organization. Its Bureau of Accounts and Statistics will be including metric conversion tables in the Board's major statistical publications. It has only a few measurement standards and it is anticipated that these could be soft converted, we were informed. It will not mandate conversion. Conversion is to be left up to the airlines and other operational agencies.

FEDERAL COMMUNICATIONS COMMISSION

The Commission regulates interstate and foreign communications by radio, television, wire, and cable.

On July 28, 1976, the Commission adopted a metric conversion program to facilitate development and the use of a single system of units in the Commission's rules. Metric units are to be used in all new and amended rules. Metric units also are to be used on all license, equipment authorization, and construction permit applications after complete conversion to metric units in the rules is accomplished. In the interim, the measurement system that is used in the relevant rules when filing an application will be used.

The program calls for a gradual two-stage conversion to metric unit usage. The first stage, beginning with the announcement of the program, will be a soft conversion with the customary units shown parenthetically. The Commission anticipates it will take about 5 years and be incorporated in the normal updating cycle and with the publishing of new and amended rules. The Commission anticipates no major problems in carrying out this conversion because actual measurements are not being changed--the terms are just being converted to their metric equivalents. Also, metric units are used in selected areas, such as frequencies (Hertz), but customary units predominate, particularly for linear measurements.

The second stage, calling for hard conversion and the exclusive use of metric units, will not begin until after the Commission assesses the pressures for exclusive use of metric units.

No cost studies have been done, but no significant costs are expected, according to a Commission official. Possibly some training will have to be provided. The official did not believe the benefits of conversion were quantifiable but believed that perhaps conversion would aid in improving communication at international conferences.

The Commission has a representative attend meetings of the interagency Metrication Subcommittee. An official believed, however, that the U.S. Metric Board should establish procedures and policies for agencies to follow to avoid disjointed and uncoordinated efforts.

A Commission official acknowledged that the Commission's program is not really voluntary, and he views the Metric Conversion Act of 1975 as requiring Federal agencies to lead. However, he pointed out that the program has not really

changed anything, and the Commission has not directed industry to change how it measures items.

INTERSTATE COMMERCE COMMISSION

The Interstate Commerce Commission regulates interstate surface transportation, including trains, buses, trucks, inland waterway and coastal shipping generally through certification of public carriers, rates, adequacy of services, purchases, and mergers.

The Interstate Commerce Commission's July 1976 policy states that it will permit carriers and agents to file tariffs and reports which include SI units in lieu of customary units. The policy requires that such tariffs and reports must contain conversion tables which explain the standards applied and methods used in conversion. The Interstate Commerce Commission is discussed further in chapter 10.

NUCLEAR REGULATORY COMMISSION

The Nuclear Regulatory Commission licenses persons and companies to build and operate nuclear reactors and to own and use nuclear materials.

Its September 1976 policy recognizes industry conversion will set the pace for metrication. It will use dual dimensions or SI units alone, if appropriate, in new or revised regulations and regulatory guides. It will convert to the SI system at a rate at least paralleling that being achieved by industry. An official informed us that safety should be no problem, as the Nuclear Regulatory Commission follows the American Society of Mechanical Engineers' Boiler and Pressure Vessel Code for nuclear components, which is being soft converted.

SMALL BUSINESS ADMINISTRATION

The Small Business Administration is in the initial planning stages for metrication. It has not issued a policy statement on metrication. According to an official, there is no pressing need for such a statement, and there has been no demand for metric information from the small business community. It participates on the interagency Metrication Subcommittee which is drafting a model policy for Federal agencies. According to an official, the Small Business Administration will probably issue a metric policy within the next fiscal year. (See ch. 5 for additional information.)

VETERANS ADMINISTRATION

According to a Veterans Administration official, full implementation of the metric system in the Federal agencies will not receive heavy emphasis until the Board is formed. However, the Veterans Administration has issued two directives pertaining to the metric system: an Administrator's memorandum in September 1976 and a circular in May 1977. The circular established a general metric policy.

These directives were issued primarily to increase employee metrication awareness. They offer some background information and suggest that some preliminary planning activities might be appropriate. The circular states that the private sector should lead the metrication process but that agency officials should consider metric use in their areas of responsibility. The circular also advises that dual units or metric-only units could be used in publication and technical papers. Finally, the circular recommends an increase of agency activity, where appropriate, in the determination of national and international metric standards. According to a Veterans Administration official, it is recognized that it will be necessary to supplement the circular with other guidelines, procedures, and policies.

An official told us that there are no real advantages in metrication for the Veterans Administration; and if the Government were to back off on its metric commitment, it would probably not convert.

CONCLUSION

Federal Government metrication activities vary widely, and there is no consistent approach to conversion. However, metrication does not appear to be a high-priority item with the Federal agencies. Only 12 of the 26 agencies contacted have formalized metric policies, and these policies generally call for the agency to respond to industry demands and not to lead. Agencies have not assessed the impact or cost of metrication, but some agencies are considering such studies. The Office of Management and Budget should provide the agencies with guidance to ensure uniform Federal policies and practices.

Generally, officials of the Federal Government agencies expect no specific benefits from metrication. If industry benefits from conversion, it is assumed that the Government will benefit.

A vast array of laws, regulations, and other requirements will have to be reviewed to ascertain the impact and type of

change. Several agencies indicated that they were looking to the Congress, the President, or the U.S. Metric Board for guidance on what metrication actions, if any, they should take.

Some agencies, such as the Department of Agriculture, believe that metrication is mandatory and have taken agressive steps to convert some operations which the public has disapproved. We find that the Metric Conversion Act of 1975 does not require anyone, Government agencies or the private sector, to convert. The Metric Act does not alter existing laws or regulations, and agencies must have existing authority or seek authority to require conversion.

Metrication by the Department of Defense is being driven by a desire for standardization, particularly with NATO countries, and a belief that metrication is inevitable. It is being impeded by a policy of nonadvocacy and a firm resolve by Defense not to pick up industry's total costs of conversion.

Measurement is an integral part of many activities and projects within Government. Without specific direction to convert its activities, we find that the Government may be frustrating industry plans. Other nations which are committed to conversion found that a strong government commitment was necessary to accomplish conversion.

RECOMMENDATIONS TO THE DIRECTOR, OFFICE OF MANAGEMENT AND BUDGET

We recommend that the Office of Management and Budget:

--Clarify for Federal agencies what they are expected to do in regard to planning and coordinating any increased use of the metric system.

--Ensure that Federal agencies establish policies consistent with the intent of the Metric Conversion Act of 1975 and inform the private sector of Federal metrication plans whenever appropriate.

--Ensure that Federal agencies convert regulations or mount other metrication activities when the initiative comes from the sectors which will be affected--industry, the States, and the general public. Federal agencies should only initiate action when they can demonstrate that such action is in the Nation's best interest.

--Require Federal agencies to inform the public of the impact of those conversion actions that affect them and hold public hearings to obtain their comments which should be considered in any final determination on such actions.

CHAPTER 23

STATE GOVERNMENTS SUPPORT BUT REMAIN INACTIVE

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STATE GOVERNMENTS SUPPORT BUT REMAIN INACTIVE

States have generally adopted a wait-and-see attitude about converting to metric. In discussions with State officials, we found little agreement, even among departments within States, about when, where, and how conversion should take place.

Thirty-five States support metric conversion; 3 oppose it, while the remainder did not take a position. Fifteen have a policy of planning voluntary conversion, and 22 indicated that they have no adopted policy. Seven say that they will convert only when and where necessary in response to the lead of the Federal Government and the private sector. One State plans a mandatory conversion of all State-controlled activities, and one plans to use the customary system indefinitely.

Twenty-four of the States have organized metrication committees or boards to assist in deciding what to do about conversion. The membership of these groups was drawn from manufacturers, farmers, labor unions, consumers, and many other fields, but State government officials and educators seemed to be more widely represented than others.

If metric conversion occurs, the majority of States believe that Government--Federal and State--legislative and economic power should be used to provide an impetus.

We surveyed the 50 States by questionnaire to obtain information about metrication views, policies, plans, and activities. We received responses from 46 States. The questionnaire used is reproduced in appendix I.

We also visited six States to discuss metrication policies, plans, and problems with State legislators, government officials, school officers and members of metrication committees. During our study we obtained and reviewed additional information from State documents, such as proposed legislation, State and school board resolutions, metrication committee minutes, reports, and other records.

STATE SUPPORT FOR METRICATION IS TENTATIVE

Thirty-five States support U.S. conversion to the metric system, although only 11 strongly support it as shown in the following table.

Support/opposition to Metric Conversion

	Number
Strongly support	11
Somewhat support	24
Undecided	6
Somewhat oppose	1
Strongly oppose	2
No basis to judge	2
Total	46

In examining available State resolutions and policy statements by legislatures, metrication committees, and boards of education, we found that the rationale for developing plans to explore metric conversion or teach the metric system in schools was based on the following:

--The metric system is now used by over 90 percent of the world's population, and an estimated 75 to 80 percent of world production and trade is measured in metric units.

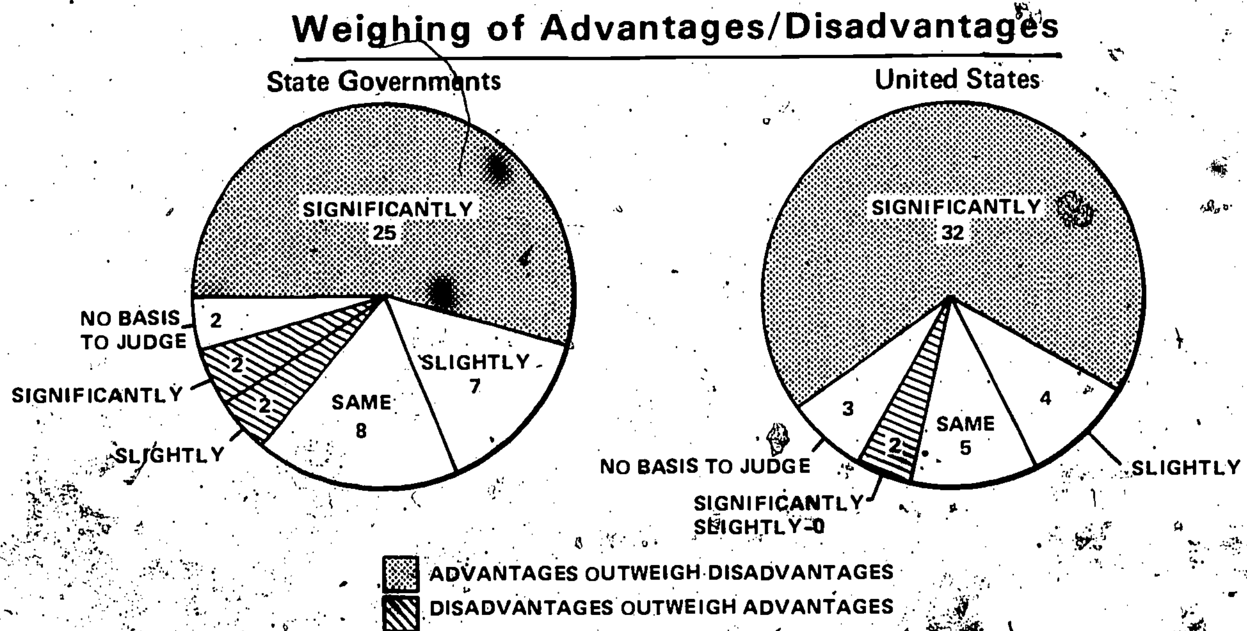
--The decisions of the United Kingdom, Canada, and Australia to metricate leaves the United States as the sole major industrialized Nation not committed to metric.

--Some major factions of U.S. industry, because of involvement with world markets, have begun to adopt the metric system.

In addition, 31 of our State contacts believed that U.S. conversion is definitely inevitable for their State government. Another 13 thought that conversion was probably inevitable. However, most States are waiting for firm leadership from the Federal Government to determine the course they should take. The majority of the States indicated that the Federal Government should plan the conversion, establish target dates, coordinate activities, and counsel and advise. They know that the U.S. Metric Board is to be organized to provide coordination and planning. They are reluctant, though, to go too far in changing State measurement systems before the Board is operational, especially because the Metric Conversion Act of 1975 does not commit the Nation to conversion.

Advantages outweigh disadvantages but State metrication is slow

Thirty-two of the State governments felt that the advantages of their going metric outweighed the disadvantages. A larger number of States (36) thought that for the United States overall, the advantages outweighed the disadvantages.



Some of the advantages of metrication, according to the States, are that the metric system is easier to use, will aid in making price comparisons of products, will increase foreign exports, provides an opportunity for standardization, and increases production efficiencies. However, over 50 percent of the States saw high costs, time needed to retrain employees, maintenance of dual inventories of materials and supplies, and confusion among customers to business as very definite disadvantages. Nineteen States thought that metrication would provide an excellent opportunity to improve building codes and standards, but 33 thought that the process of changing these codes and standards would be a disadvantage.

Officials in the six States we visited gave several reasons for the slow pace of State metrication:

--The Metric Conversion Act is too weak and does not commit the country to conversion. State agencies are skeptical about moving headlong into conversion

without coordination and some indication of milestones or target dates. The U.S. Metric Board is sorely needed.

--Federal Government departments, especially those which regulate, should provide more and better leadership.

--Metric conversion is costly.

--State agencies should react to conversion changes initiated by industry. They should not be the initiators.

--Coordination must be made so that individual States do not become metric "islands" among neighboring States.

Many State governments see metric conversion as a non-crisis oriented, expensive activity with very few near-term benefits. They also question the wisdom of proceeding into conversion out of phase with other States, thereby creating a confusing and possibly dangerous environment for interstate travelers and those engaged in interstate commerce.

We identified five States which have passed legislation promoting metrication. A few others have proposed metric legislation, but it has not yet been passed. Most of the States, however, have not seen fit to introduce or amend laws to support conversion.

Most of the States, however, prompted by the 1974 amendments to the Elementary and Secondary Education Act which authorized funds for metric education, have emphasized that schools in the States will incorporate metric education in their curriculums. (Ch. 24 of this report discusses metric education.)

GOVERNMENT ACTIONS COULD FACILITATE METRICATION

Twelve of the States strongly agreed that the United States should encourage conversion by tying metric requirements to Federal funds granted to States for education, transportation, housing, and the like. However, another 12 States strongly disagreed with this idea. Seventeen States agreed somewhat, and three disagreed somewhat. Two States were undecided. These responses show that more than 50 percent of the States would be willing to convert to the degree required by Federal funding programs.

Almost all of the States (44) either strongly or somewhat agreed that the Federal Government should encourage metrication through procurement of metric items. Forty-one

agreed that the State governments should encourage conversion through procurement, while four of the States were undecided on this question. Only one State disagreed. The following table shows the States' views.

Views on the Use of Grants and Procurement to Encourage State Metrication

	Agree strongly	Agree somewhat	Undecided	Disagree somewhat	Disagree strongly	No response
U.S. should encourage conversion through grants	12	17	2	3	12	-
U.S. should encourage conversion through procurement	29	15	-	-	-	2
States should encourage conversion through procurement	23	18	4	1	-	-

Thus, a majority of States believe that government, both at the Federal and State level, should use its economic powers to provide impetus to the metrication movement.

Most States also agreed that their metrication efforts would be facilitated if the U.S. Government would establish target dates for voluntary conversion, provide financial and technical assistance to States, change all Federal laws that specify use of the customary system, and develop a national metrication plan. Twenty-seven of the States also agreed that making conversion mandatory with established deadlines would help State metrication. These matters with others are shown in the following table.

Effect of U.S. Actions on State Metrication

	Facilitate	Hinder	No effect	No basis to judge	No response
Make conversion mandatory	27	15	1	2	1
Establish targets for voluntary conversion	39	4	2	-	1
Provide financial aid	43	1	2	-	
Provide technical aid	41	1	3	-	1
Change laws that specify customary	44	2	-	-	-
Develop national plan	42	3	-	1	-

Some officials in Pennsylvania stated that the concept of letting the costs "lie where they fall" may have to be reconsidered by the Federal Government. The costs of running State governments, one said, are increasing faster than the costs of operating the Federal Government or industry. He added that Federal assistance may be needed to help finance State agency conversion.

A Georgia official told us that he does not expect much progress from States unless there is a strong Federal policy or mandate. State governments, he said, are not likely to voluntarily generate enthusiasm or allocate necessary resources to projects which do not have crisis orientation. His opinion was that many State Governors regard metrication as a low priority item.

Officials in Georgia felt that the Federal Government should develop a firm national conversion plan with target dates. The plan could still allow for flexibility and voluntary conversion within the limits of the dates. Target dates should be reasonable and tailored to the different sectors of the economy.

Individual States cannot act independently on metrication. This could lead to chaos just in the area of interstate commerce. The States need strong direction from the U.S. Metric Board before they can make significant advances toward conversion.

Federal Government actions could also affect the time needed to convert. Forty-five States said that their government could convert within 15 years if the United States converts to the metric system. Thirty-three of these indicated they would only need 5 to 10 years. However, if conversion is not made mandatory, only 35 States thought that they could convert within a 15-year period. Eight States would need more than 15 years, including two who would need between 21 and 25 years.

Optimum Time Needed to Convert

	Mandatory	Nonmandatory
Less than 5 years	5	2
5 to 10 years	33	20
11 to 15 years	7	13
16 to 20 years	1	6
21 to 25 years	-	2
26 to 50 years	-	-
More than 50 years	-	-
No response	-	3

METRIC LEGISLATION

Legislators say the United States must lead

State legislators we talked to generally felt that the Federal Government needed to make a firm commitment to metric and provide leadership in conversion. One said that a State cannot become unique and adopt a system which has not been adopted by other States. It would be ridiculous to use two measurement languages in trade and communication that goes on between States. Some were in favor of metric conversion because of its potential of helping the United States compete in the international marketplace to maintain a favorable balance of payments. One legislative assistant felt that the U.S. Government should encourage industry to convert. He felt that legislative mandates and strong coercion would not be effective, but gentle coercion in some cases may be in order.

1974 law stimulates metric education

Among State government activities, State departments of education were the most active. This may be because the Educational Amendments of 1974 declared that U.S. policy encourages educational agencies and institutions to prepare students to use the International System of Units metric system as part of the regular education program. Since 1976, 147 metric

grants in 49 States and 3 territories have been awarded with Federal funds appropriated for this purpose. (See ch. 24.)

Other State agencies operating for the most part without the guidance of strong national legislation, Federal funding, and State metric laws are not nearly as active.

Six State laws promote conversion

We have identified only six State laws which promote metrication:

--The Minnesota Metric Implementation and Standards Act of 1974, which calls for statewide planning for metric conversion.

--A California Act of 1977, which established a metric board similar to the one provided by the national Metric Conversion Act of 1975.

--New York's amendments to the Agriculture and Markets Law, which establishes metric as the preferred system of measurement.

--A New York motor vehicles law, which requires new motor vehicles registered after September 1, 1980, to have dual speedometers.

--South Carolina's 1977 legislation to provide for implementation of the metric system.

--A Louisiana act amending land measurement requirements.

We also found two States--Oklahoma and Colorado--which passed legislation in opposition to metric conversion.

Minnesota Metric Implementation Act

The Minnesota Metric Implementation and Standards Act of 1974 stated that it was the purpose of the State to "begin the gradual but deliberate implementation of the metric system of weights and measures." This law charged the Minnesota Commissioner of Administration with responsibility for promulgating rules and regulations to

--provide for the full conversion of the State's commerce to the metric system when the U.S. Congress adopts this system as the national standard and

--insure that all State departments, divisions, agencies, boards, and commissions having authority and/or responsibility in matters concerning weights and measurement shall initiate planning for the gradual conversion to the metric system.

The Commissioner of Education also was to consult with the Commissioner of Administration to develop and implement a plan of public education on the metric system.

The act stated that because the continued economic growth of the State and local industry is so closely linked with the ability of the United States to competitively serve foreign export markets, it is in the best interest of Minnesota to begin gradual conversion. The act, however, did not give the Commissioner of Administration enforcement authority, or provide funds for implementation.

On February 10, 1975, the "Minnesota Plan for Metric Education" and "A Resolution on Metrication" were approved by the State Board of Education.

According to the plan, by 1984, 90 percent of the teachers are to be teaching predominantly metric with only incidental teaching of the customary system.

The State Governor and the Commissioner of Administration appointed a metric council with representatives from education, transportation, weights and measures, administration, and the Governor's office. This council was to oversee the development of the plan for metric education and begin planning for State metrication activities. The council began a study of measurement-sensitive statutes which would need to be changed to implement conversion. It discovered that some statutes would need only soft conversion while others would have to be hard converted. Examples of these conversions are (1) the legal distance required between a liquor store and a school would be soft converted to an equivalent distance in metric and (2) the gallons of fuel oil delivered to homes would have to be hard converted to liters.

In addition, the metric council developed a metric style guide for government secretaries and held discussions about metric procurement with State personnel. They also urged radio and television stations to use metric measurements in weather reports.

We were told that although the Metric Conversion Act of 1975 did not adopt the metric system as the national standard as anticipated by the Minnesota Act of 1974, the State would

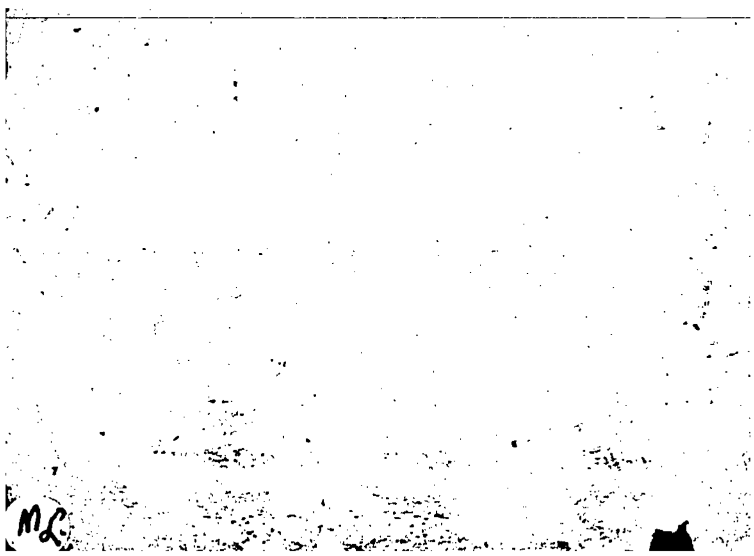
proceed with its program of planning for gradual but deliberate implementation of conversion. At the time of our visit in November 1976 we found the education plan was being implemented, but we did not find much conversion planning in other parts of the State government. For example, the director of the Department of Weights and Measures said that the department will not become involved in metrication until changes occur in consumer products. He did say, however, that they are buying new equipment with dual capability. An official of the State Highway Department said that the highway metrication committee, which had been organized in 1972, had become inactive when Federal legislation failed to call for national mandatory conversion. We also found that as of November 1976, the metric style guide which had been developed for government secretaries had not been published and distributed.

According to the metric council chairman, a certain amount of legislated coercion is needed. He endorses setting targets for various sectors, such as the dates established in the States' plan for education.

The former State legislator who introduced the metric implementation act thinks that States should show support and commitment to metric as strongly as possible because State action may influence the Federal Government to act more decisively about metric conversion. He said that a good example was when certain States promulgated regulations specifying safer automobile bumpers, the Federal Government was influenced to adopt similar national regulations. He felt also that the ultimate direction our country will take depends on actions by the U.S. Metric Board. He told us that arrangements had been made for one of his colleagues to introduce a bill to set up the Minnesota Metric Council by statute instead of being a group appointed by the Governor. He feels that this would ensure continuity in metrication activities independent of the Governor's interest as administrations change.

Federal law makes Government seem indifferent

The principal investigator in the National Science Foundation-funded study, "Metric Transition in the United States," who is also a member of the Minnesota Metric Council, told us that the study report discussed two alternative scenarios: (1) metrication under existing legislation and (2) metrication with a stronger commitment from the Congress and the Federal Government. He reminded us that the Metric Conversion Act does not commit the United States. It makes conversion an option. The existing law makes it appear that the Federal



Government is indifferent to the system of measurement. Government, he said, "cannot afford to be indifferent, and at some point must specifically say as much, and commit the country to metrication." Resources of the Government must be deployed to achieve the goal. The investigator believes that in some instances the Government will have to give assistance when organizations have attempted to go metric and cannot complete the process without help.

California organizes a metric conversion council

After an unsuccessful attempt in 1973 to pass a bill calling for the State's conversion to the metric system, the California State Legislature in late 1977 passed a law to provide an orderly conversion to the system and to provide coordination with the U.S. Metric Board's program.

Starting in January 1978, a California Metric Conversion Council will be created in the Department of Food and Agriculture. Its members will include the Director of Food and Agriculture and 10 other members appointed by the Governor and confirmed by the State Senate. Appointed members will represent engineering, science, industry, retailers, labor, small business, construction, education, consumers, and weights and measures. An additional $50,000 was appropriated to the Department of Food and Agriculture's 1977 to 1978 budget to carry out the provision of the act.

The legislation requires that the Council's efforts complement those of the U.S. Metric Board as they relate to California. Its duties on a State level coincide with the Board's duties on the national level. The Council is responsible for taking into account the interests, views, and conversion costs of California's commerce and industry. It must provide for procedures whereby various Council groups may recommend to the Council specific programs for coordinating conversion in each industry, publicize proposed programs, and provide an opportunity for interested groups or individuals to submit comments. It will encourage standards organizations to develop metric engineering standards.

The Council will also help the public become familiar with the meaning and applicability of metric terms and applications in daily life through the media and talks to appropriate groups. It will counsel and consult with educational associations, local education agencies, labor education committees, apprentice training committees, and other interested groups to ensure that metric instruction is included in the State's educational institutions and that teachers are properly trained to teach the metric system.

The act provides that the Council will be operative until 1985. However, it does not set targets or a date when the metric system will be the predominant system of measurement in California. The Council, though, is responsible for an annual status report to the legislature and the Governor on the extent to which conversion has been achieved, projections for the conversion process, and recommendations covering needed legislative or executive action to implement the programs accepted by the Council. Similar to the U.S. Metric Board, the Council was not provided any compulsory powers. It must be noted that the California metric bill became law without the Governor's signature.

New York adopts metric as the preferred system

In August 1977 New York State enacted a new article 16 of the portion of its Agriculture and Markets Law that deals with weights and measures. One major feature of the act was that the metric system was adopted as the preferred system of measurement within the State. Section 177 states:

> "177. Authorized systems of weights and measures; basic units. 1. The metric system of weights and measures and the system of weights and measures in customary use in the United States are jointly recognized, and either system shall be used for all commercial purposes within the state. However, the International Metric System ('SI'), as defined in the Metric Conversion Act of nineteen hundred seventy-five (Public Law 94-168) and as such definition may hereafter be amended, is hereby adopted as the preferred system within the State."

Chapter 300 of the New York Laws of 1976 requires that all new motor vehicles registered in New York after September 1, 1980, be equipped with speedometers calibrated in both miles and kilometers. National Highway Traffic Safety Administration regulations now require that all vehicles manufactured after August 31, 1979, be equipped with speedometers that register speed in both miles per hour and kilometers per hour. (See ch. 10.)

The Governor's approval memorandum filed with the act stated that the amendments to the weights and measures statutes were the first in more than 50 years and would eliminate many obsolete sections, consolidate and eliminate other sections, and enact a new framework for current commercial usage and consumer needs. The previous version of the weights and measures law adopted in 1922 authorized customary units only.

Although the act authorizes the use and establishes preference for the metric system, it does not set targets or project when metric may be used more than customary. However, in its statement of policy and purpose of the act, the legislature declared that voluntary and orderly conversion to metric is of vital importance to the economy of the State. The legislature also declared that the public policy of the State would be to encourage gradual implementation of the metric system throughout the State's government, industry, commerce, business education, and agriculture. Section 177 was enacted to encourage such implementation by providing a code of weights and measures responsive to present and future needs.

South Carolina begins plans for conversion

The General Assembly of South Carolina stated that the continued economic growth of the State and its local industry is closely linked with the ability of the United States to hold and competitively serve foreign markets. The Assembly declared that to begin now to gradually and deliberately implement the metric system is in the best interest of the State and its citizens. Therefore, in June 1977 the legislature adopted an Act to Provide for the Implementation of the Metric System of Weights and Measures.

The act assigned, to the Commissioner of Agriculture, general authority over implementation activities and provided for a nine-member advisory committee to assist. The committee is to be made up of the executive officers, or designated staff members, of the State Law Enforcement Division, the Commission on Higher Education, the State Board for Technical and Comprehensive Education, the Department of Education, the State Highway Department, the Alcoholic Beverage Control Commission, the State Development Board, one member appointed by the Governor who is associated with the textile industry, and one member appointed by the Governor from his staff.

The committee is to formulate a plan for the gradual implementation of South Carolina commerce to convert to the metric system. It is to provide recommendations to the General Assembly for achieving conversion of units of measurement and encourage all State departments, divisions, agencies, and others having authority in weights and measures matters to initiate planning for gradual conversion.

This act also established a Metric Education Committee to develop and encourage implementation of a metric education plan, with emphasis on the immediate requirements of the

commercial and industrial community, and a long-range plan of public education. There was no appropriation to carry on the work of the committees and no dates for accomplishment of the tasks.

The South Carolina metric act concentrates on planning for conversion of industry and commerce. However, the textile industry is the only one represented on the advisory board. The textile industry is South Carolina's largest, comprising about 34 percent of the value of all manufactured products and employing the most workers. Other major State industries, such as chemicals, apparel, paper, food products, machinery, and stoneclay-glass products, are not represented.

Louisiana allows metric land measurement

Before 1977 Louisiana statutes required all land and area measurement and description to be in inches, links, feet, furlongs, miles, and other units of the customary system. However, in July 1977, anticipating increasing metrication, the legislature added a new section to the Louisiana statutes to allow descriptions and contracts using metric units to be valid. The enabling act, however, declared that "The United States customary system of measurement shall be the primary method of land and area measurement." Weights and measures' regulations in Louisiana are based on the customary system. (See ch. 20 for further information on surveying and mapping.)

Two States say metrication is premature; Oklahoma requests a moratorium

Oklahoma is one of the States whose legislature has reacted negatively to the Nation's efforts to encourage metrication. In May 1977 the legislature approved House Resolution 1014. This resolution declared that the U.S. Congress has debated for 200 years on whether to mandate a conversion to the metric system and a multitude of problems are developing due to the lack of a firm public policy concerning conversion. Therefore, the legislature requested and recommended that the Congress declare a moratorium on conversion to the metric system and prohibit all Federal boards and agencies from directing or implementing conversion until such time, if any, the Congress decides to mandate conversion and establishes timetables, guidelines, and procedures to implement such a conversion. Copies of this resolution were sent to every member of the Senate and the House of Representatives.

Colorado not ready for metric highways

In spite of Colorado's planning for conversion, the State legislature found it necessary in early 1977 to petition the Congress to prohibit the conversion of land measurement to metric. When the legislature found that the Federal Government (the Highway Administration) had plans to convert highway signs to the metric system by 1982, it adopted a resolution petitioning the Congress

> "to provide by law that the 'Metric Conversion Act of 1975' shall not require conversion of land and highway mileage measurements to the metric system, and to provide for the cessation of efforts by the U.S. Metric Board to convert the highway system to metric measurements."

Copies of the resolution were to be sent to the President of the Senate; the Speaker of the House of Representatives; each member of the Congress from the States of Colorado, Wyoming, Nebraska, Kansas, Oklahoma, New Mexico, Arizona, and Utah; and the Governors and legislatures of each of the above States. (See ch. 10 for information about the proposed change of highway signs.)

The legislature of Colorado had adopted a joint resolution in 1974 resolving that all State agencies should develop recommendations with a view toward eventual exclusive use of the metric system and that all schools in Colorado should intensify the teaching of metric. It stated that efforts should be made to acquaint the citizens of the State with the system because, among other reasons, the metric system, once mastered, can be used more effectively and with more understanding than the customary system. The resolution also recognized that a single standard of measurement based on the metric system was quickly becoming a reality.

The Colorado Advisory Committee on Metric Conversion, a subcommittee of the Scientific Advisory Council, submitted a report to the Governor on May 31, 1976. The report discussed rising costs, labor, consumers, small business, and the coordination of State regulations and agency capabilities as issues which would need to be addressed if conversion is to be implemented. It also discussed Federal initiatives, such as the Metric Conversion Act and the 1974 amendments to the Elementary and Secondary Education Act, and their impacts on Colorado. It attempted to predict timetables for periods of national activity--initiation of action (1975 to 1977), planning (1978 to 1979) and beginning of changeover (1980 to 1981).

The Committee's consensus was that, in general, the more progressive industries would play a leading role in moving the American economy into the metric system. Government, however, would have an important role to play in educating students and the public, training workers, and creating an atmosphere favorable to metrication. The Committee's major recommendation was that the Governor appoint a Metric Advisory Council with central authority to provide the State with metrication policy and provide continued guidance for each of the transition issues over the decade or so.

We talked to a State official who said that although there has been no metric activity within the Colorado State government since the Advisory Committee's report, there is no change in the State's acceptance of metric conversion as inevitable. However, the legislature thought that the Federal Highway Administration's action was premature and left the financial burden of conversion of signs on the State. He said that a more reasonable consideration of timeliness and some provision for financial assistance would not have provoked the petition.

STATE AGENCY METRICATION ACTIVITIES

Highway metrication

Most State highway departments became involved in metrication in 1977 when the Federal Highway Administration proposed a plan to require metric highway signs throughout all States. Although 20 States had voluntarily installed from 2 to 44 all-metric or dual signs for information and gradual orientation of motorists, the proposal was highly unpopular and the Highway Administration withdrew the plan. (See ch. 10.)

Twenty-one States saw obtaining funds to defray the costs of sign changeover as the biggest problem. The range of estimates from the 13 States that furnished us figures was from $185,000 to $20 million to do the job. Fourteen also saw public resistance as a big factor. Twenty-five States indicated that when highway signs are required to change, the Federal Government should share the cost. Eleven felt that the Federal Government should pay the entire cost.

However, Connecticut which had installed four dual signs, anticipating that Federal regulations would soon require metric signs, ordered the signs removed when the Federal Highway Administration's proposed schedule for converting highway signs was withdrawn. An official of the State's highway department said there was no use educating the public for something the Federal Government was not going to be serious about.

Ohio's Department of Transportation has done considerable research on the impacts involved in metric highway construction. Ohio completed, from design through construction, two highway improvement projects. Surveyors, engineers, contractors, materials suppliers, and the road construction labor force were involved. However, Ohio regards the experience as useful research that may be used in the future but has no plans to continue metric highway construction.

The only State metrication law affecting transportation we were able to identify was previously discussed in this chapter under New York legislation. The subject of highway metrication is more thoroughly discussed in chapter 10.

Weights and measures agencies wait for industry

Although in 1866 an act of the Congress declared it lawful throughout the United States to employ the weights and measures of the metric system, many State and Federal laws and regulations require that the customary system of measurement be used. For example, in Montana, by law, bread must be marketed in 1/2 pound, pound, 1-1/2 pound, and multiples of 1 pound quantities; and milk must be sold in 1/2 pint, pint, quart, and gallon quantities. Throughout the United States, highway speeds are limited in miles per hour, and liquor stores must, by law, be located at least a certain number of feet from schools.

Only 12 States thought that present weights and measures laws and regulations would make it difficult for the State government to convert to the metric system. Thirty-six States use the National Bureau of Standards Handbook 44, which gives customary specifications and technical requirements for commercial weights and measuring devices, as the sole State standard or as a supplement to State-developed standards.

NBS is developing a metric version of Handbook 44 which, when completed, could be adopted by States as a basis for metrication of weights and measures. Thirty-nine States indicated that they would use the metric Handbook 44 in the same way they currently use the existing customary version. More than one-half of the States said that their weights and measures regulations are already broad enough to allow merchants to sell loose consumer goods (fresh fruits, vegetables, meats, and grain) by metric weights and volumes without changes. Others said that merchants could not change from customary weights or volumes unless regulations were amended.

Sixteen States saw building codes and construction standards as a major problem to change, while another 16 said

that changing these regulations would be a minor problem or no problem at all. In other areas, such as traffic regulation, standards of measure for consumer goods, education, agriculture, and drug control, most States thought that regulations would be a minor problem or no problem if the State decided to metricate.

Weights and measures agencies are waiting until metrication by industry requires them to change weights and measures regulations and convert testing and sealing equipment. An exception was the California Division of Measurement Standards. This agency had drafted a proposed plan for conversion which intends to lead California industry into the metric system. However, its plans may be slowed and subjected to plans for coordination by the newly formed California Metric Conversion Council discussed earlier in this chapter.

The division has already done much training of county weights and measures personnel in the use of the metric system. It also has been procuring metric equipment and helping employees understand how some items of customary equipment can be adapted to metric use when necessary in their work. The director of the division has been engaged in general public information by giving speeches to groups of citizens.

It is doubtful whether divisions of weights and measures in other States will promote metrication in industry. They believe it will be better to let industry discover the merits of the metric system and let conversion evolve as an advantageous thing to do. One official said the only people moving positively toward metrication now are those who have business interests in foreign countries. And even they are using both customary and metric. None have abandoned customary completely. Another remarked that the role in measurement in his division is to be sure that the consumer receives accurate measurement no matter what system is used.

Although most weights and measures agencies are not assuming initiative, they say they can be ready to regulate industrial conversion on short notice. Twenty-nine States, responding to a question about agency capability, indicated that their weights and measures personnel are highly or fully capable of testing and approving metric scales and other measuring devices, although only 18 of the agencies were highly or fully capable in terms of equipment needed to do the job. Thirty-two agencies indicated that 5 percent or less of their present work deals with inspecting metric weighing or measuring devices.

Those with which we discussed the problem of training personnel and acquiring equipment indicated that neither would be a problem for the State department, but may present some difficulty for county and local staffs. Many would expect help with training from NBS which already, using U.S. Office of Education metric education funds, has conducted a series of metric workshops for State and local weights and measures personnel. Twenty-eight of the States thought that conversion of weights and measures activities would incur moderate additional expense to the agencies' budgets, but 13 thought that the conversion would mean high additional costs.

General services agencies resist conversion

General services agencies were generally resisting metrication. These departments, which are responsible for the design, construction, and maintenance of State buildings, are not metricating because (1) industry is not ready to furnish all of the components for metrically designed projects, (2) metrically designed structures would require metric maintenance parts which, with parts needed to maintain existing structures, would require dual inventories, and (3) contractors are not accustomed to estimating and building in metric.

Liquor control agencies react to a mandate

Urged by the wine and distilled spirits industries, the Bureau of Alcohol, Tobacco and Firearms of the Department of the Treasury has adopted new regulations requiring metric-size bottles for wine bottled after December 31, 1978, and liquor bottled after December 31, 1979. Stores throughout the country are already selling the new bottle sizes.

State liquor control agencies have been forced to train employees, change their recordkeeping and accounting procedures, and make other adjustments to accommodate the switch to metric. Industrial pressure and Federal regulation should cause these agencies to continue rapid metrication. (Conversion of wine and liquor bottle sizes is discussed fully in ch. 26.)

Other State agencies are inactive

Among the other agencies--Labor, Consumer Affairs, Economic Development, Procurement, Environmental Resources, Highway Patrol, Motor Vehicles, Health, Small Business--in the six States we visited, there was some planning as to what the impacts of metrication would be, but little or no action.

Education agencies are active

As noted previously, State departments of education had active programs in all the States we visited. We believe this is because (1) the Educational Amendments of 1974 stated U.S. policy about education of students in metric usage, (2) funds were available for assistance, and (3) although coordination of education among States is desirable, it is not necessary. Education, incidentally, is the only area for which specific Federal funds are available. (See ch. 24.)

CONCLUSIONS

The policy expressed in the Metric Conversion Act of 1975 that the United States will coordinate and plan the increasing use of the metric system does not appear to be enough of a Federal metrication commitment to cause the States to convert their operations. For the most part, States have adopted a wait-and-see attitude. States agree that the metric system may be good for multinational corporations in improving their world trade and an easier and more logical system to be used by everyone. However, their deep involvement in conversion will come only when the actions of industry and the U.S. Government give stronger and more immediate reasons for a change. At such time we feel that affected State laws and operations will be converted as needed.

It is not reasonable to expect States to initiate the imposition of a new system of measurement on intrastate affairs without strong incentives. In interstate affairs, careful coordination by the Federal Government will be necessary to avoid confusion and disruption in the regulation of commerce and other matters. The States are looking for some form of leadership from the Federal Government and have not yet received it, particularly with regard to a firm national commitment as to which system--metric or customary--the United States is to predominantly use.

RECOMMENDATION TO THE CHAIRMAN, U.S. METRIC BOARD

We recommend that the U.S. Metric Board develop avenues through which the States may define their roles and coordinate appropriate voluntary conversion activities among other States under the current national policy. The National Governors Conference, which has organized an Interstate Metric Committee composed of State representatives appointed by Governors, possibly could become the focal point for this effort.

U. S. GENERAL ACCOUNTING OFFICE

METRIC TASK FORCE

SURVEY OF STATE GOVERNMENTS

INSTRUCTIONS:

Please answer each of the following questions as frankly and completely as possible.

We are interested in your views whether or not you consider yourself to be as knowledgeable about our questions as you like to be. Answers on others' views need not be based on formal surveys of their opinions.

There is space at the end of the questionnaire for any comments you may wish to make concerning the questionnaire, or any other related topics.

The questionnaire is numbered only to permit us to delete your name from our list when we receive your completed questionnaire and thus avoid sending you an unnecessary followup request.

RESPONDENT INFORMATION:

NAME: ______________________

TITLE: ______________________

TELEPHONE: ( ) ______________________
(Area code) (Number)

A. Federal Laws and Policies

1. What is your understanding of the national policy concerning converting to the metric system? (Please check one.)

- [ ] No stated national policy
- [ ] Mandatory conversion within 10 years
- [ ] Federal coordination and planning of voluntary conversion
- [ ] A mandatory, gradual conversion (i.e. more than 10 years)
- [ ] No conversion
- [ ] Don't know
- [ ] Other (Please specify) ______________________

2. If metric conversion occurs, which of the following roles, if any, should the Federal Government assume? (Please check all that apply.)

- [ ] Plan the overall conversion
- [ ] Coordinate activities
- [ ] Establish target dates
- [ ] Counsel and advise interested parties
- [ ] Legislate the conversion process
- [ ] Make conversion mandatory
- [ ] Enforce the conversion process
- [ ] Other (Please specify) ______________________
- [ ] None of the above
- [ ] No basis to judge

APPENDIX I

3. Which of the following Federal laws and regulations would make it difficult for your state government to convert to the metric system? (Please check all that apply.)

- [ ] Occupational safety and health laws and regulations
- [ ] Environmental protection laws and regulations
- [ ] Weights and measures laws and regulations
- [ ] Packaging and labeling laws and regulations
- [ ] Other consumer protection laws and regulations (Please specify) ______
- [ ] Federal-aid Highway funding laws and regulations
- [ ] Building and construction standards and regulations (i.e. HUD minimum property requirements)
- [ ] Other (Please specify) ______
- [ ] None of the above
- [ ] No basis to judge

4. Should the Federal Government encourage conversion to the metric system through requirements tied to Federal funds granted to states and local governments (i.e. Federal funds for education, transportation, housing, etc.)? (Please check one.)

- [ ] Strongly agree
- [ ] Agree somewhat
- [ ] Undecided
- [ ] Disagree somewhat
- [ ] Strongly disagree

5. Should the Federal government encourage conversion to the metric system by purchasing items designed or described in metric terms? (Please check one.)

- [ ] Strongly agree
- [ ] Agree somewhat
- [ ] Undecided
- [ ] Disagree somewhat
- [ ] Strongly disagree

6. If the U.S. Government took the following actions, how much, in your opinion, would such actions hinder or facilitate metrication in your State? (Check one box for each row.)

	No basis to judge 1	Greatly hinder 2	Hinder 3	No effect 4	Facilitate 5	Greatly facilitate 6
Made conversion mandatory, including establishing deadlines						
Established target dates for voluntary conversion						
Provided financial aid to States						
Provided technical assistance to States						
Identified and changed all Federal laws that specify use of customary units						
Developed a national plan for metrication in all sectors of U.S. activity						
Other (Please specify) ______						

B. State Laws and Policies

7. What official policy, if any, has your state government with regard to converting to the metric system? (Please check one.)

- [ ] None (Skip to question 9)
- [ ] Continue use of the customary system indefinitely
- [ ] Plan voluntary conversion to metric of state and state-controlled activities
- [ ] Plan mandatory conversion to metric of state and state-controlled activities
- [ ] Follow the lead of the private sector, convert when and where necessary
- [ ] Follow the lead of the Federal Government, convert when and where necessary to comply with Federal regulations and requirements
- [ ] Other (Please specify) ______

8. What official action was taken to document or legalize this policy (Please check all that apply.)

- [ ] No official action was necessary
- [ ] New or amended state law approved
- [ ] Legislative resolution adopted
- [ ] Executive order by state governor issued
- [ ] New or amended weights and measures regulation(s) adopted
- [ ] Policy statement by metric coordinator, committee, or board adopted
- [ ] Other (Please specify) ______________

9. Should State governments encourage conversion to the metric system by purchasing items designed or described in meteric terms? (Please check one.)

- [ ] Strongly agree
- [ ] Agree somewhat
- [ ] Undecided
- [ ] Disagree somewhat
- [ ] Strongly disagree

10. In the selling, by weight, of loose consumer goods (fresh fruits and vegetables, meats, etc.), do your present weights and measures laws or regulations permit wholesalers and retailers to change from using weighing scales that read out in customary to scales that read out in metric? (Please check one.)

- [ ] Yes, no restrictions
- [ ] Yes, after obtaining State authorization
- [ ] Yes, with the following qualifications (Please specify) ______________
- [ ] No, unless laws or regulations are amended

11. In the selling, by volume, of loose consumer goods (gasoline, grain, draft beer, etc.), do your present weights and measures laws or regulations permit wholesalers and retailers to change from using customary measures to using metric measures? (Please check one.)

- [ ] Yes, no restrictions
- [ ] Yes, after obtaining State authorization
- [ ] Yes, with the following qualifications (Please specify) ______________
- [ ] No, unless laws or regulations are amended

APPENDIX I

12. Would State laws and regulations be a problem in converting to the metric system in the following areas? (Please check one box for each row.)

	Major problem 1	Minor problem 2	No problem 3	No basis to judge 4
Motor Vehicles (licensing, safety)				
Roadways (construction, maintenance)				
Traffic (speed, parking, other regulations)				
Labeling (consumer goods)				
Standards of measure (gasoline, etc.)				
Standards of fill packaged goods				
Environment (pollution, conservation)				
Education				
Building Codes, construction standards				
Liquor, Drugs, Alcohol				
Industrial Safety				
Procurement (goods and services)				
Agriculture (feed, fertilizer, pesticide regulations)				
Other (Please specify) ______________				

C. Support or Opposition to Metric Conversion

13. Does your State government support or oppose the United States' converting to the metric system? (Please check one.)

- [ ] Strongly support
- [ ] Somewhat support
- [ ] Undecided (the state government)
- [ ] Somewhat oppose
- [ ] Strongly oppose
- [ ] No basis to judge (you)

APPENDIX I

14. Do you believe that conversion to the metric system is inevitable for your State government? (Please check one.)

- ☐ Definitely yes
- ☐ Probably yes
- ☐ Undecided
- ☐ Probably no
- ☐ Definitely no

15. Has a state-level committee, board, commission or other group been organized to assist in conversion to metrics?

- ☐ Yes
- ☐ No (If no, skip to question 18)

16. Please indicate the name of that group in the space below.

____

____

17. Which of the interests listed below are represented by at least one person on your metric group? (Please check all that apply.)

- ☐ State legislature
- ☐ Manufacturing industry
- ☐ Farming industry
- ☐ Education - Public/Private/Parochial
- ☐ State government operations
- ☐ Construction industry
- ☐ Citizens/Consumers
- ☐ Wholesale/Retail Sales
- ☐ Transportation industry
- ☐ Medical/Legal professions
- ☐ Labor unions
- ☐ Other (Please specify) ________________

____

D. State Metrication Activity

18. What is the current status of metric conversion activities in the following agencies in your State? (Please check as many boxes as necessary to indicate activities completed or in progress.)

AGENCY	No activity	Adopt conversion policy	Select personnel to direct and coordinate activities	Analyze cost of conversion	Budget estimated funds	Change laws and regulations which prohibit metric conversion	Train appropriate personnel in metric	Inform the public of conversion policy and regulations	Establish milestones for implementation	Purchase necessary tools and equipment	Coordinate with industry	Coordinate with local governments
	1	2	3	4	5	6	7	8	9	10	11	12
Health and Welfare												
Transportation												
Education												
Agriculture												
Weight[illegible]nd Measures												
Liqu[illegible]trol												
General Services												
Procurement												
Law Enforcement												
Consumer Affairs												
Building Codes and Permits												

19. Have any metric traffic signs been installed on State-controlled highways in your State? (Please check one.)

- [ ] Yes
- [ ] No (If no, skip to question 21)

20. How many metric signs of the following types have been installed? When were the first and the latest signs installed? (Please indicate your answers in the boxes below.)

	Number	First Installation (Year)	Latest Installation (Year)
Speed limit signs			
Warning and regulatory signs			
Guide signs, other advisory signs			

21. What is the estimated cost of converting all speed limit signs (State and local) in your State to the metric system using the same method used to change to the 55 mile per hour speed signs.

____

22. What is the estimated cost to change all highway and street signs, including speed signs to the metric system.

____

Who should pay the cost?

- [ ] State for State signs and local for local signs
- [ ] State Governments
- [ ] Federal Government
- [ ] Share with Federal Government

23. What in your view would be your State's biggest problem if the Federal Highway Administration required changeover of all highway signs to metric by 1982? (Please check one.)

- [ ] Obtaining funds to offset the costs
- [ ] Public resistance to change to metric signs
- [ ] Completing the work of changing the necessary signs
- [ ] Enforcing the speed laws until cars are equipped with metric speedometers
- [ ] Other (Please specify) ______________________

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24. How would you rate your State department of weights and measures' present capability to test and approve metric scales and other measuring devices? (Check one box on each row.)

	Fully or almost fully capable (1)	Highly capable (2)	Moderately capable (3)	Not capable or almost not capable (4)
Personnel				
Equipment				

25. How much of the present approving and sealing activity of your State weights and measures department deals with metric devices? (Please check one.)

- [ ] Less than 1%
- [ ] 1% to 5%
- [ ] 6% to 10%
- [ ] 11% to 20%
- [ ] More than 20%
- [ ] Do not know

26. What is the status of the use of NBS Handbook 44, Specifications, Tolerances and Other Technical Requirements for Commerical Weights and Measuring Devices, in your State. (Please check one.)

- [ ] Officially adopted as the basic guide supplemented by State-developed standards
- [ ] Officially adopted as a supplement to basically State-developed standards
- [ ] Officially adopted as the sole State standard
- [ ] Not officially adopted
- [ ] Other (Please specify) ______________________

27. When the metric version of Handbook 44 is completed by the National Bureau of Standards, will your department of weights and measures use it in much the same way as the present version? (Please check one.)

- Yes
- No

E. Costs/Funding

28. In your view, how would you rate the cost of metric conversion in the government operations listed below? (Check one box in each row.)

	High additional cost (1)	Moderate additional cost (2)	No additional cost (3)	Moderately less cost (4)	Substantially less cost (5)
Weights and measures					
State building construction and maintenance					
Transportation regulation and control					
Highway building and maintenance					
Education					

29. Has the Federal Government provided any financial assistance to your State metrication efforts? (Check one.)

- Yes
- No (If no, skip to question 32)

30. Please state the federal program source(s) of these funds.

31. Approximate the dollar amount of federal financial assistance. (Check one.)

- Less than $10,000
- $10,000 to $24,999
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $100,000
- More than $100,000

32. Approximate the dollar amount of State funds (excluding education funds) used so far for metrication activities. (Check one.)

- None
- Less than $10,000
- $10,000 to $24,999
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $100,000
- More than $100,000

33. Approximate the dollar amount of State funds (excluding education funds) budgeted for future metrication activities. (Check one.)

- None
- Less than $10,000
- $10,000 to $24,999
- $25,000 to $49,999
- $50,000 to $74,999
- $75,000 to $100,000
- More than $100,000

F. Potential Impacts of Metric Conversion

34. Listed below are several ADVANTAGES frequently attributed to conversion to the metric system. (Please indicate whether you agree or disagree that each would be a significant advantage for your State. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED ADVANTAGES	Agree (1)	Disagree (2)	Does not apply (3)	No basis to judge (4)
The metric system is easier to use and would result in fewer errors				
Conversion will increase or protect the present amount of export and/or work overseas of U.S. firms				
Conversion will provide an opportunity to standardize products				
Trade will be facilitated through a common measurement language				
Use of the metric system will increase production efficiencies				
Use of the metric system will facilitate technological advances				
Conversion will provide an opportunity for improving building codes and standards				
Conversion will stimulate industry				
Use of the metric system will aid in comparing the prices of products				

35. Listed below are several DISADVANTAGES frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant disadvantage for YOUR STATE GOVERNMENT. (Please check one box for each row.)

FREQUENTLY ATTRIBUTED DISADVANTAGES	Agree 1	Disagree 2	Does not apply 3	No basis to judge 4
Conversion will be costly				
Training employees will be time consuming				
Conversion will result in dual inventories				
Customers will be confused by the metric system				
Conversion will increase the prices of products and services				
Conversion will result in safety hazards and errors				
Sales will be lost to foreign imports				
Conversion of building products will require retesting				
Building codes and standards will have to be changed				

36. For your State government, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

- [ ] Advantages significantly outweigh disadvantages
- [ ] Advantage slightly outweigh disadvantages
- [ ] Advantages would be about the same as disadvantages
- [ ] Disadvantages slightly outweigh advantages
- [ ] Disadvantages significanly outweigh advantages
- [ ] No basis to judge

37. For the United States overall, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

- [ ] Advantages significantly outweigh disadvantages
- [ ] Advantages slightly outweigh disadvantages
- [ ] Advantages would be about the same as disadvantages
- [ ] Disadvantages slightly outweigh advantages
- [ ] Disadvantages significantly outweigh advantages
- [ ] No basis to judge

G. Schedules - Time Frames For Metric Conversion

38. If the United States converts to the metric system, approximately what would be the shortest time frame for your State government to convert? (Please check one.)

- [ ] Less than 5 years
- [ ] 5 - 10 years
- [ ] 11 - 15 years
- [ ] 16 - 20 years
- [ ] 21 - 25 years
- [ ] 26 - 50 years
- [ ] More than 50 years
- [ ] Never

COMMENTS: ______________________________

39. If conversion is not made mandatory, what would be the optimum amount of time your State government would need to convert? (Please check one.)

- [ ] Less than 5 years
- [ ] 5 - 10 years
- [ ] 11 - 15 years
- [ ] 16 - 20 years
- [ ] 21 - 25 years
- [ ] 26 - 50 years
- [ ] More than 50 years
- [ ] Never

COMMENTS: ______________________________

APPENDIX I

40. If you have additional comments on any of the items within the questionnaire or related topics not covered, please feel free to express your views in the space below or attach additional data. We would be especially interested in receiving copies of laws, regulations, resolutions, state plans or other documents which establish state or local policy toward conversion to the metric system?

CHAPTER 24

METRIC EDUCATION IS ON ITS WAY

Page

CHAPTER 24

METRIC EDUCATION IS ON ITS WAY

Children are being taught the metric system in schools throughout the Nation. All State education agencies support metrication. Some States have set target dates when metrics will be the principal measurement system taught. Others have not seen fit to work toward specific targets. However, 13 States have set 1980 as the target date when the metric system will be taught as the predominant system in their schools.

Teachers were evenly divided about whether metric should be taught as the predominant system of measurement or whether both metric and customary should be taught on an equal basis for a long time. State education authorities' views differ on how long students will need a dual measurement capability. Depending on the long-range metrication timetables of some industries and the possibility that some segments of the economy will not convert at all, it is likely that the customary system will need to be taught along with metric for many years.

State education authorities feel that metric education can be incorporated into the school program at little cost after teachers are trained. Costs for travel to training sessions, payment of substitute teachers while regular teachers are being trained, and stipends to teachers for additional time in training and purchase of materials could be substantial. On the other hand, in the classroom metric instructional materials and textbooks can be provided at little or no expense as expendable materials are replaced and textbooks are obtained during a normal cycle.

Over the last 3 years, the U.S. Office of Education was provided approximately $6.3 million for metric education. This program was authorized under the 1974 Elementary and Secondary Education Amendments Act which provided for a program of grants and contracts in order to encourage institutions of higher education; State and local education agencies; and other public and private nonprofit agencies, organizations, and institutions to prepare students to use the metric system. The program manager told us that the cost of introducing metric education in the schools will be higher than originally expected, although no cost figures were provided.

We discussed metric education with officials in the U.S. Office of Education, the National Institute of Education, and national education associations. We talked to professors in colleges and universities. We also visited officers of the State education agencies of six States and surveyed the State

education agencies of the entire 50 States and 3 territories by questionnaire to get information on metric views, projects, plans, and problems. The questionnaire used is reproduced in appendix I.

METRIC VIEWS OF ALL THE STATE EDUCATION AGENCIES

We obtained a 100-percent response to the questionnaire we sent to the 50 States, Washington, D.C., Puerto Rico, and American Samoa. (Hereafter, we will refer to the respondents as States.) The questionnaires were sent directly to persons whom we had identified as the responsible State metric education officials. Many of these were officials in the mathematics departments.

National policy understood

Most of the respondents (46) understood that the national policy is one of Federal coordination and planning of voluntary conversion. However, four did not know that there was a stated national policy. One thought the policy called for gradual mandatory conversion, and one thought that mandatory conversion was to be accomplished in 10 years.

Metrication receives strong support

All respondents supported U.S. conversion to metric. Thirty-four strongly supported conversion, and 19 supported it to a lesser degree. This support for national conversion probably accounts for the fact that most States and territories have or are planning metric education activities for their schools.

Teacher sentiment favorable

Fifty of our questionnaire respondents were of the opinion that teacher sentiment toward teaching the metric system was favorable. Their views were about evenly divided between (1) those who thought teachers believe that we should start now to establish metric as the predominant system because national conversion is inevitable and (2) those who thought teachers favor teaching the metric and customary systems on an equal basis because the country will need both for a long time.

Our survey showed that the majority feel that teachers are willing to teach metric either predominantly or equally with customary.

Role of Federal Government

The questionnaire respondents' views on the role of the Federal Government strongly favored coordination and establishment of target dates, as shown in the following table.

Agency Views on the Role of Federal Government

Agency view	Number of States
Plan conversion	38
Coordinate activities	46
Establish targets	45
Counsel and advise	37
Legislate the process	17
Make conversion mandatory	15
Enforce conversion	12
Other	6

1980 is a big target year

Half of the States had decided to work toward predominantly metric instruction. Most of these had established target dates to accomplish this objective. As can be seen in the following schedule, 13 of these States had set 1980, only 2 years away, as their target date.

Target Dates For Conversion of State Schools to Metric Instruction

1978	1980	1981	1982	1983	1984	1985
Calif.	Ariz.	Ky.	Miss.	Minn.	Idaho	La.
	Del.	N.C.		Oreg.		
	Fla.	W.Va.		Vt.		
	Ill.					
	Maine					
	Md.					
	Mass.					
	Neb.					
	N.Y.					
	N.Dak.					
	R.I.					
	Utah					
	Wash.					

New Jersey's State board of education passed a resolution in 1973 which "urged" its school districts to initiate a program of instruction so that metric will be the "primary language of measurement at all levels of instruction by

1976." In November 1977 when we checked to see if the target had been attained, an official of the State education department told us that there had been no significant increase in metric instruction in the State's schools since the resolution. He said that part of the problem may be that New Jersey does not have a State mathematics curriculum that would assist by giving time, scope, and sequence of metric instruction to districts needing such help. He also stated that urging does not mandate compliance. He noted, however, that because the State's tests of mathematics basic skills now contain metric items, school districts will be influenced to give greater emphasis to metric instruction in their curricula.

In 1974 a resolution was introduced in the State's legislature requesting the State board of education to make its urging of the school district a mandatory order. However, this resolution was never passed.

Of those responding, most thought that measurement instruction could be converted to metric in 10 years or less. Twenty-five felt it could be done in less than 5 years.

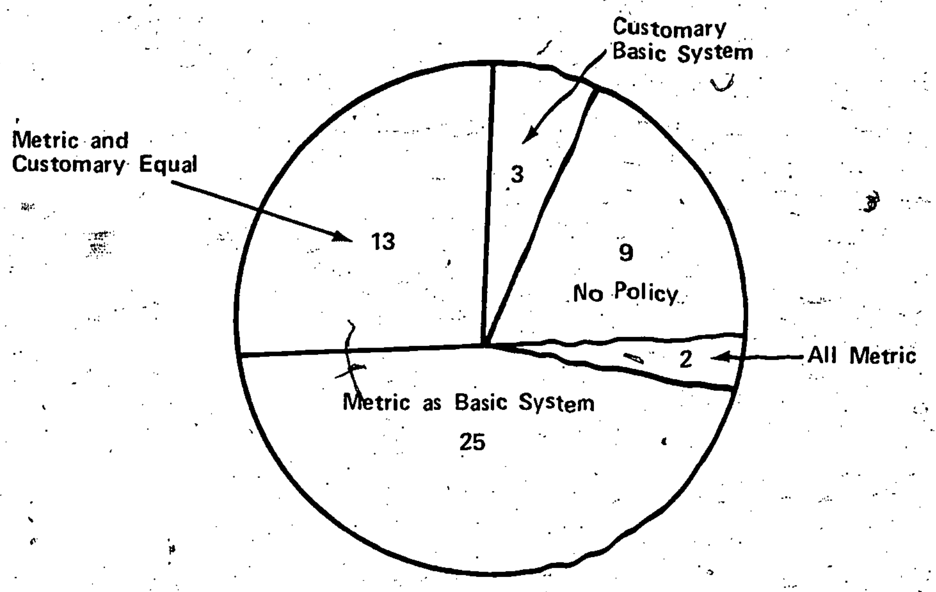
The need to continue teaching some customary measurement was estimated at 10 years or less by 29 of the respondents; more than 10 years by 16. Of the latter, seven felt that customary instruction would be needed indefinitely. Eight respondents felt they had no basis to judge.

<u>Current education policy plans toward the metric system</u>

As shown in the following chart, 25 State education agencies have adopted a policy in all grades of teaching metric measurement as the basic system with minor instruction in customary measurement.

Thirteen States had decided to teach metric and customary with equal emphasis in all grades and subjects. Three will continue to teach the customary system in all grades but with minor instruction in metric. Only two had adopted a policy of teaching only metric in all grades. The policy of three States was to teach some metric now and increase instruction as dictated by the speed of conversion in society. Nine of the State agencies had no clear cut policy about metric in their instructional programs.

State Education Agency Policy Toward Metric Instruction



The American school system, comprised of about 17,000 school districts, is highly decentralized, and States do not have strong control over what is taught in their schools. Only 22 States have a mathematics curriculum developed at the State education agency level. Nineteen of these are merely suggestive guidelines from which local school districts may develop their own mathematics curriculum. Few of the States felt that they could legally require that metric be included in local curricula. Therefore, most States may not be able to implement their metric policies in all local school districts.

However, almost half (25) of the respondents have a policy in which the State education agency approves the textbooks to be purchased by school districts with State education funds. Nineteen of these indicated that State approval of textbooks could be one way that the State agency could influence the growth of metric instruction in local school districts.

Metric instruction in the States

Some metric instruction is taking place in over half of the school districts in the country. Many of the States indicated that they were just getting started in planning and curriculum development, orientation or training of teachers, and procuring necessary instructional materials. The biggest problem indicated was that teachers do not have the necessary knowledge and skills to teach metric. However, during the

past 5 years, 38 of the States said most of the time and effort directed toward the metric education program was for teacher training; only 1 said that most of the time and effort was spent on classroom instruction.

The emphasis on metric instruction has changed over the past 5 years. Metric was not a major emphasis in any grade level in 1972. At present, 8 of the States will give major emphasis to metric in grades kindergarten through 3; 11, in grades 4 through 8; and 4, in grades 9 through 12. Most of the schools now will give moderate emphasis in all grades as contrasted to minor or no emphasis 5 years ago.

The curriculum areas affected a great deal by metric instruction will be mathematics, science, home economics, industrial arts, and vocational/technical subjects. Physical and health education will be affected somewhat. Respondents felt that language arts, social studies, and fine arts will be affected very little or not at all.

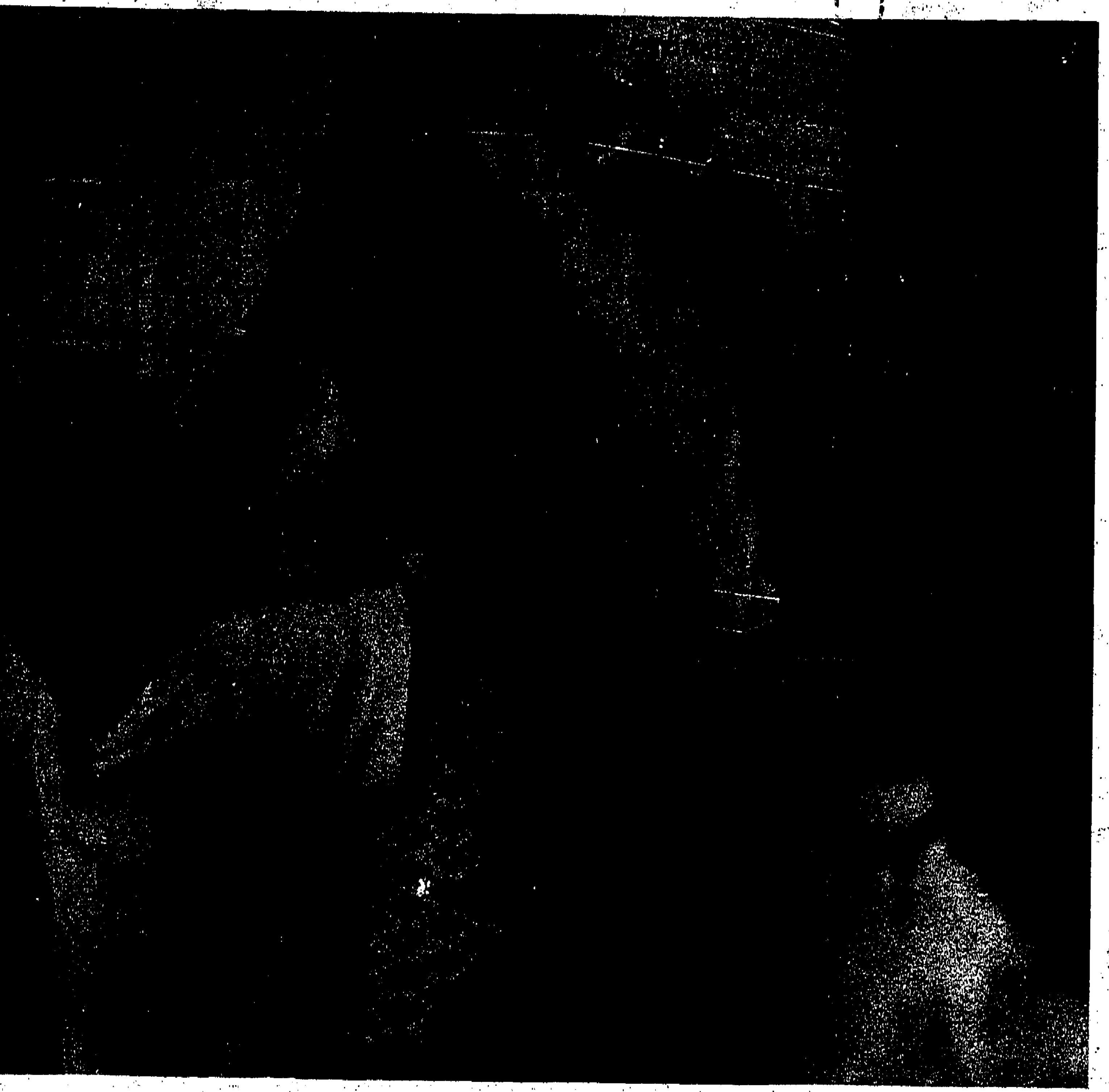
Thirty-two respondents felt that the metric system will be easier to teach than the customary system, and 49 felt that students will learn metric easier and make fewer errors. Twenty-nine of our respondents believe that once learned, metric skills will be retained by students even in the predominantly customary world in which they live. However, 18 thought that metric skills would be quickly lost because most everyday activities are still customary.

Advantages outweigh disadvantages

State education agencies thought that the advantages of converting to the metric system outweighed the disadvantages to their educational programs. Thirty-seven thought the advantages would be significant, and 10 thought there would be slight advantage. Four thought the advantages would be equal to the disadvantages. Although two had no basis to judge, none felt that teaching metric would be disadvantageous.

Fifty-one respondents thought that among students with no prior measurement skills, metric could be learned faster; 8 thought slightly faster; and 43, significantly faster. Two thought there would be no difference. However, only 23 of 53 respondents agreed that the time saved would be sufficient to teach additional subjects not now in the curriculum.

The majority thought that the metric system would be easier to teach and learn and that the system would enhance students' achievement in scientific, vocational, and technical subjects. Forty-nine felt that use of the metric system would result in fewer errors although 26 did not believe



SOME METRIC INSTRUCTION IS TAKING PLACE IN OVER HALF OF THE SCHOOL DISTRICTS IN THE UNITED STATES.

PHOTO COURTESY OF THE NATIONAL COUNCIL OF TEACHERS OF MATHEMATICS.

it is a more accurate system. The following chart shows how State authorities viewed frequently attributed advantages of metric instruction.

Advantages of Metric Instruction
as Viewed by Respondents

Advantages	Agree	Disagree	No basis to judge
The metric system is easier to teach and would allow more time to teach other things.	32	17	4
The metric system is easier to learn and will result in fewer errors.	49	1	3
Metric measurement is more accurate.	22	26	4
Metric instruction helps students learn fractions easier.	7	36	9
The metric system will enhance students' achievement in scientific, vocational, and technical subjects.	37	7	9

The majority did not anticipate that conversion to metric would confuse teachers and students or be costly in terms of staff training or procurement of textbooks and other materials, as shown in the following chart.

Disadvantages of Metric Instruction as Viewed by Respondents

Disadvantages	Agree	Disagree	No basis to judge
Conversion to the metric system will confuse students.	3	49	1
Conversion to the metric system will confuse teachers with resulting loss of productivity.	10	42	1
Staff retraining will be costly.	16	37	-
Changing textbooks and other instructional materials will be costly.	12	38	2
Metric measurement skills will be quickly lost because everyday activities are still based on customary.	18	29	6

Costs of conversion

State education agency respondents did not feel that metric instruction would drastically affect normal costs. Most felt that additional costs incurred would be moderate to slight. In some cases the opinion was that savings may even result.

Thirty-seven of the respondents indicated that during the last 5 years most of the money spent for metric education was for teacher training, 10 spent most for planning and curriculum development, and the remainder spent most for various other activities.

At the time of our inquiry, 47 of the States had expended less than $50,000 of Federal funds for metric education activities since 1970. Forty-five estimated they had spent less than $50,000 in State funds on metric education since 1970. Most of the State education agencies had spent less than $10,000.

Eleven of the agencies reported no expenditures of Federal funds and eight reported no expenditures of State funds during the period.

U.S. OFFICE OF EDUCATION ACTIVITY

The Office of Education, Department of Health, Education, and Welfare, has been involved in metric education since 1972. Programs funded by the Office of Education have been designed to develop metric education instructional materials in vocational, technical, and adult education and teacher training materials for people with sight handicaps, reading difficulties, and other learning deficiencies. Other funded programs were directed toward developing working models which States and territories could use in the transition to metric education and planning how the Nation's educational institutions can best prepare Americans to understand and use metrics. Those programs were supported by the Office of Education through funds not specifically appropriated for metric education--elementary, technical, adult, and research funds. Legislation passed in August 1974, however, specifically provided for metric education grants in fiscal years 1976, 1977 and 1978. A total of $6.3 million was appropriated for this grant program.

Early metric education projects

Five major metric education grants were awarded by the Office of Education before the specific metric education program, authorized in 1974 to begin funding projects in fiscal year 1976.

Metrication of technical career education

Western Michigan University was awarded a grant of $163,241 to develop teacher training programs and materials for metric instruction in technical career education. Manufacturing companies and associations, including a machine tool company involved in metric products, were advisors to the project. The materials developed were tested in 125 colleges. Because no copyright is involved, these materials are available for use without restriction. The program was begun in 1972 and completed in 1976.

Metric conversion in vocational education

Western Michigan University directed the Conversion in Vocational Education Program parallel to and coordinated with the Metrication of Technical Career Education Program. This project, however, was to develop curriculum analyses for education and training programs in manufacturing, construction, business and office practice, and the health area. Major emphasis was directed toward minority groups. Funding of

$98,840 came from vocational research funds. Business and industry, especially manufacturing, were advisors.

Vocational, technical, and adult education

In June 1974 Ohio State University was awarded a 3-year contract for the development and utilization of metric instructional materials in vocational, technical, and adult education. The objectives were to prepare an annotated bibliography of metric education materials, write a position paper on the problems and issues of a metric education program, develop instructional packages, and conduct training workshops for teachers in each of the 10 Office of Education regions. This project, completed in 1977, was cofunded with vocational and technical education curriculum development and adult education funds totaling $496,071.

Five-State Consortium on Metric Education

The Five-State Consortium on Metric Education was comprised of the States of California, Delaware, Minnesota, Mississippi, and North Carolina. With North Carolina as the administrative State, the Consortium set out in July 1974 to develop some working models in metric education which other States and territories could use in transition to the metric system.

Each State was assigned major responsibility for parts of the project and all were asked to develop a phased plan for metrication within their respective States. Plans were to be shared with all States as a means of advancing national metrication. Funding for the Five-State Consortium was $65,000 from elementary and secondary education funds.

Interstate Consortium on Metric Education

The Interstate Consortium on Metric Education consisted of representatives of 28 States and territories which met in 1974 for the purpose of planning how the Nation's educational institutions can best prepare Americans to understand and use metrics. The States and territories selected were those that have centralized textbook adoption policies because they have the greatest impact on textbook content. The Consortium's efforts were directed toward guidelines for developing effective instructional materials for teachers and pupils, mounting a public awareness program to support the school effort, and developing suggestions for teacher inservice training. Funding for this project was $81,000.

The Interstate Consortium recognized that the use of customary units would continue in the United States for an undetermined period of time and that the two systems of measurement would exist in many schools. However, they anticipated that special needs will place customary units in a different role and that they will eventually acquire a status of merely historical reference.

The Consortium produced a report containing 23 recommendations. These included recommendations that

--for matters concerning definition of units, style, and spelling in the International System of Units, the National Bureau of Standards' metric system guide (NBS-330) and industry's metric practice guide (American Society for Testing and Materials publication E380-72) be used in preparation of instructional materials;

--conversions be avoided;

--the metric system be taught throughout the school curriculum;

--metric public awareness programs precede adoption of metric educational materials;

--January 1980 be the target date for completion of transition of textbooks and other instructional materials; and

--business, industry, and other organizations be informed and involved in transition.

In October 1974 a committee of eight members met with major textbook publishers to explain the recommendations and answer questions. It was felt that by alerting publishers about the impending change to metric, they would be better prepared to meet requests for metric education materials.

Direct assistance for metric education

On August 21, 1974, the Congress enacted Public Law 93-380, an amendment to the Elementary and Secondary Education Act of 1965. Public Law 93-380 was the first act to authorize funds specifically for metric education. In section 403 of the act the Congress declares that it is the policy of the United States to encourage educational agencies and institutions to prepare students to use the SI metric system as part of the regular education program. This statement of policy was based on the reasoning that (1) the metric system is in general use in industrially developed nations, (2) increased use in the United States is inevitable, and the metric system

will become the dominant system of weights and measures, and (3) there is no existing Federal program designed to teach children to use the metric system, and such a program is necessary if the American people are to adapt to metric use.

This legislation, which provided for metric education, was part of a package of educational amendments which also included provisions for gifted and talented students, community schools, career education, consumer education, women's equity in educational programs, and arts in educational programs. The assertions about the metric system's dominance and inevitability were directed to the educational community to get the schools going in teaching metric. Later the Metric Conversion Act of 1975, which established a much broader policy for the entire Nation, omitted these assertions. The 1975 Act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected.

As provided by the 1974 Education Amendments Act, the Commissioner of Education is responsible for implementing a program of grants and contracts in order to encourage institutes of higher education; State and local education agencies; and other public and private nonprofit agencies, organizations, and institutions to prepare students to use the metric system. The Commissioner was authorized $10 million for each of the 3 fiscal years ending before July 1978. Actual funding, however amounted to approximately $2.1 million for each of the 3 years.

The manager of the Metric Education Program told us that his experience in implementing this program has shown that school administrators have discovered that introducing metric education in schools will require higher expenditures than expected. Specific cost figures were not provided. He said that sufficient resources are not being given to school districts, and many metric programs are in danger of being abandoned. A Vocational Education official with the U.S. Office of Education stated that there will be costs involved in acquiring new equipment and in converting existing equipment used in vocational education programs.

A Metric Education Program staff was established, and 72 grants were awarded in fiscal year 1976. Twenty-two were awarded to State education departments; 14, to local school districts; 28, to colleges and universities; and 8, to nonprofit public and private institutions. Seventy-five grants were made in fiscal year 1977--6, to State education departments; 34, to local school districts; 27, to colleges and universities; and 8, to nonprofit institutions. Sixty-six grants

were made in fiscal year 1978--2, to State education departments; 38, to local school districts; 20, to colleges and universities; and 6, to nonprofit institutions.

The overwhelming majority of the projects funded were planned to train teachers. Grants were made to three consortia of States. Two of these projects trained teachers to function as leaders to train other teachers in their communities, while the other developed curriculum guidelines and materials through an interstate planning council composed of representatives from each State's department of education. A total of 22 States participated in these consortia.

The American Institutes for Research in Palo Alto, California, received Office of Education grants of $165,004 in fiscal year 1976 and $72,054 in fiscal year 1977 to provide metric education technical support to all other grantees. Among other services, they established a tollfree number to handle calls from grantees all over the country and provided consultants to handle onsite problems when necessary.

A METRIC EDUCATION PROGRAM GRANT HELPED NORTH CAROLINA TEACHERS LEARN TO TEACH METRIC.

PHOTO COURTESY OF JAMES BARRINGER, SALISBURY POST

Under an interagency agreement, NBS was provided $35,000 for training State weights and measures officers. We question whether this contract was consistent with the intent of the Educational Amendments, which was to support activities to prepare students to use the metric system.

Public information program

In August 1976 the Office of Public Affairs of the Office of Education in cooperation with the Metric Education Program mounted a radio-television public information campaign. The objective was to provide information to the public about the metric system, and to help dispel the public's fear of metrics by attempting to show people that the metric system is easier to use than customary. It also pointed out that the United States is the only industrialized Nation not committed to the metric system. The campaign, "Take 10 America," included public service spots for radio and television and a poster for responding to inquiries about the metric system. Variations of the spots were made to appeal to low-literacy adults, children not receiving metric instruction in schools, teachers, and adults with at least a high school education.

Spots were developed and distributed under contract at a cost of about $63,000. Three hundred and fifty television stations and 1,267 radio stations agreed to air the spots at no charge. The Office of Education had 120,000 posters printed at a cost of about $36,000. As of March 1978, these posters had been mailed to requestors at a cost of about $43,000. The Office had received requests for 100,000 additional posters.

We noticed that the letter from the U.S. Commissioner of Education to radio and television stations requesting their support states in error that, "The National Metric Conversion Act of 1975 provides for voluntary changeover within a 10-year timeframe." This type of statement contributes to one of the misunderstandings of the metric act that we have noted. Many do not understand that there is no time limit provided for in the act and, in fact, there is no national policy to convert.

THE NATIONAL INSTITUTE OF EDUCATION

The National Institute of Education, which was created by the Congress in 1972 "to help solve or alleviate" critical problems of American education through research and development, initially funded two projects in metric education research. "Going Metric," dated 1974, took a superficial look at the impact of metric conversion on the education system of other countries--United Kingdom, New Zealand, Australia, South Africa, and Canada. In 1975 "Metric Inservice Teacher Training: Learning from the English and Australian Experience"

specifically reviewed the inservice teacher training programs of England and Australia to determine their applicability in the United States. Both were done under contract with the American Institutes for Research for $25,000 and $23,000, respectively. Both reports were made available to the public.

"Going Metric" identified three needs for successful conversion: (1) broad scale involvement of all major elements in early planning, (2) committed government policy and firm schedules, and (3) continued communication and coordination.

"Metric Inservice Teacher Training" emphasizes that the decentralized nature of America s educational system makes a coordinated, well-planned, teacher training strategy absolutely necessary.

The National Institute later funded two additional metric projects. In 1976 David Nero and Associates were granted $60,000 to perform a metric needs assessment by surveying 50 State and 6 territorial departments of education and a sampling of teachers colleges to find out what is required in the way of preservice and inservice education of teachers and what materials are needed to conduct metric courses. In March 1977 the American Institutes for Research was granted $50,000 to conduct a study of the education agencies of seven Canadian provinces to identify the successes and failures encountered in metric educational implementation. Both studies are scheduled for completion by the spring of 1978. Findings will be sent to the U.S. Metric Board and disseminated to State and local education agencies to assist these bodies in making decisions about metric education.

STATE EDUCATION ACTIVITIES

We visited the State education agencies of California, Georgia, Maryland, Minnesota, Ohio, and Pennsylvania to get more detailed information on the status of metric education activities. Metric education activities were at varying levels in each State. Although metric instruction was well advanced in the classrooms of Maryland, most of the others were at various levels of teacher training.

All of the States we visited are receiving Federal metric education funds. In fiscal year 1976, 14 grants to State education agencies, local education agencies, nonprofit organizations, and colleges in the six States totaled more than $500,000. In fiscal year 1977, 12 grants totaled $327,000.

The Minnesota State education department was operating under a firm statute by the legislature that the State would begin "the gradual but deliberate implementation of the metric

system of weights and measures." The act specifically authorized the Commissioner of Education, along with the Commissioner of Administration, to develop and implement a plan of public education in the metric system. This act, passed in 1974, anticipated that the U.S. Congress would pass a metric conversion act providing for a predominantly metric America. The other States' moves toward metric instruction were motivated by the chief State school officer or the State board of education.

California, Maryland, and Minnesota have set target dates for accomplishing conversion in public schools. In Maryland 1980 will be the date when the metric system will be predominantly used in all instructional areas. In Minnesota 1983 is the target date when 90 percent of the State's teachers will be teaching customary measure only incidentally. California has established 1988 as the year when graduating high school students will have had metric education in all grades, kindergarten through high school, and 1978 as the year when some metric would be taught in all grades.

Except for the costs of training teachers, most States felt that metric education will increase educational costs only slightly. If planned well, textbooks with necessary metric content can be brought in within normal turnover periods. The same holds true for rulers, volume measures, scales, and other teaching aids. Teachers are also urged to supplement commercial materials with weights and measures made of easily obtained everyday materials, such as coins, stones, paper cups, and the like.

Some problems of the States

In Georgia we were told by a State official that no target dates have been set because they cannot foresee a time when customary measurement will not be needed. The official said that schools must teach what students need. To gear the school to all-metric instruction is impractical. Even if the United States makes a firm commitment to go metric, educators must coordinate the balance between customary and metric instruction with the pace of change in industry. According to the official, when the student is really confronted with metric in industry, the store, and other places, metric can be taught exclusively with customary left to be taught incidentally.

Although target dates have been set, an official in California said that the Federal Government must exercise more leadership if we are to convert successfully. Resistance to conversion is aggravated because metrics are not seen in such

places as the supermarket, the drug store, and the gas station. Even in the dual labeling on some packages, the metric units are often incorrect. Either view--"Educators must begin now to prepare students for a metric world" or "There is no rush to change students to metric thinking"--could be true. Leadership is needed very soon to help us decide which of these views should influence educators. This official also thinks that the Metric Conversion Act is too permissive.

In one State we were told that interest in metric education is neither high among school administrators nor among the classroom teachers who will ultimately determine the success or failure of metric education.

One problem faced by five of the States was that although the State department exercises leadership in conversion to metric education, the local school districts make their own decisions about teaching metric. There are about 2,800 school districts in the six States we visited, representing about 12.6 million students in grades kindergarten through 12. Three of the States have a mathematics curriculum developed by the State education department, but these are only suggestive guides from which school districts may develop their own curriculum. The other States did not have a State-developed curriculum. Therefore, except for Minnesota, whose metric program is reinforced by legislation, there are no controls to ensure that metric measurement will be taught. Most felt that stronger Federal legislation is necessary to influence State education laws.

HIGHER EDUCATION

University schools of education and teachers colleges have begun to train teachers to use and teach the metric system. Some of these have been assisted with funds granted by the U.S. Office of Education's Metric Education Program. During fiscal years 1976, 1977, and 1978, 75 grants totaling more than $2 million were awarded to institutions of higher learning. Most of the institutions' projects were for education of teachers. Many of the teacher training institutions we contacted were conducting metric workshops in nearby school districts or inservice college credit courses on campus.

Two university schools of education we contacted have made metric instruction a required part of the preservice courses in elementary and secondary mathematics. One of these schools also requires the students to include metric as part of their practice teaching in regular classrooms. The official directing the program said that this not only gave the

students practice, but gave confidence to the regular classroom teachers who were generally insecure about their competence in teaching metric.

The American Society for Engineering Education is encouraging conversion to metric instruction in university schools of engineering. In June 1977 the Society's Metrication Coordination Committee passed a resolution stating that metrication is important to the present and future welfare of the United States and urging the President and the Congress to exercise leadership to prevent delays in national conversion. They suggested that the Congress use the metric system in the wording of its laws and also take appropriate action to modify existing laws that may preclude use of the system.

Committee members told us that the Society is trying to draft policies urging engineering schools to convert to at least dual instruction. They would like as many textbooks and as much laboratory equipment as possible to be converted.

Professors in schools of engineering told us they are, for the most part, increasing the use of metric in their courses as textbooks become available and laboratory equipment can be secured or converted. Textbooks with exercises in metric have been a problem but are now becoming more available. Most are dual, but some are all metric. (Thermodynamics and Heat Transfer are subjects which now have good all-metric textbooks.)

Professors we interviewed said that the difficulties of using metric in engineering courses may vary with the subject matter of the course. Much of electrical engineering has always been metric, although transformer design is basically customary. Mechanical engineering has used metric and customary. Civil engineering, petroleum, and geological engineering are basically customary.

Several professors said they have found that an hour or two introduction to metric measurement is all the time needed to devote exclusively to the system. Students increase their metric measurement skills as they learn the subject. One said that since students have begun using metric, the errors made in simply converting from one customary unit to another (inches to feet, feet to yards, etc.) have been eliminated. Now, because of the simplicity and logic of the metric system, students can concentrate more on course concepts.

One engineering school requires that all theses for Ph.D and masters degrees use metric as the primary system followed by customary in parentheses. Another school requires metric only in all term papers.

Undergraduate college courses, especially in the basic sciences (chemistry, physics, biology) and mathematics, and home economics, are increasing use of the SI metric system. Metric is not taught as a seperate mathematics subject, such as statistics, but the system's vocabulary and units are introduced and used where appropriate. Although many courses in science have always used some metric, it has not in many cases been SI. In these cases the system is being updated. The course in introductory physics at one school we contacted uses all SI metric. One university metrication chairman said what the students learn about metric in core undergraduate courses is sufficient background for more specialized use of the system in graduate schools of engineering, architecture, medicine, and the like.

Some universities in their continuing education programs have offered metric education to groups such as nurses, executives and workers in industry, small businessmen, alumni, and others. One small southern university has trained about 150 nurses, technicians, dieticians, and maintenance personnel at the nearby Veteran's Administration hospital and the municipal hospital. The courses, which ranged from 3 to 10 hours, emphasized the relationship of metric to the materials and equipment used by the workers. Another large university has initiated a telephone hookup which can be used along with slides and other materials to give metric training to remote groups of learners--mainly groups of nurses. We talked to two universities which have included metric in their agricultural extension courses.

We noted strong acceptance of metric among the college instructors we interviewed. They felt that the system is logical, simple, and does not require difficult conversions within the system as does customary. There was some concern, however, that the Nation will not be metricated for a long time. One professor said that national conversion will be slow because many of the decisions which will influence its progress will be made by those who have not been given sufficient reasons to change. He mentioned small businessmen as an example. Another stated that the beauty and logic of the system is not enough to sell it. We need national commitment and marketing people to promote it.

EDUCATIONAL MATERIALS

We visited the National Council of Teachers of Mathematics Teacher/Learning Center at Reston, Virginia, to examine metric instructional aids. The collection on display there is one of the largest in the country. We found that there is no shortage of materials on the market. In addition to the textbooks and workbooks, there were kits, games, manipulative

aids, films and filmstrips, charts and posters, slides, transparancies, and records. Some were produced in the United Kingdom and Canada. These teaching aids were provided by vendors for display purposes and ranged through all teaching levels, primary through postsecondary.

As a service to schools and parents, the Council has compiled a guide to the suppliers of metric materials. Materials are listed by producer, kind of material, and educational level. No effort has been made to evaluate the materials because the Council does not endorse commercial products. We could see that quality ranged from very poor to excellent in terms of construction, treatment of metric units, and durability.

CONCLUSIONS

The 1974 Education Amendments Act which provided for metric education, was part of a package of educational amendments which also included provisions for gifted and talented students, community schools, career education, consumer education, women's equity in educational programs, and arts in educational programs. The assertions about the metric system's dominance and inevitability were directed to the educational community to get the schools going in teaching metric. Later the Metric Conversion Act of 1975, which established a much broader policy for the entire Nation, omitted these assertions. The 1975 Act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected. Under the Educational Amendments the Government appears to be an advocate of metric conversion while no such intent is expressed in the Metric Conversion Act which established the national policy.

Urged by the Educational Amendments which also provide funding, it appears that the educational community is working to prepare students for an "inevitably predominant metric system" that depends on voluntary metrication by other sectors--industry, transportation, sports, merchandising, construction, medicine, and others.

There is no assurance that these other sectors will cause metric measurement to be predominant in day-to-day activities--at the store, the gas station, in recreation, traveling the highways, and at work--by the mid-1980s when many States expect to have achieved metric predominance in instructional programs. We believe the "inevitability of metric conversion" of the United States assumed in the Educational Amendments is not a certainty without a firm Government commitment.

The issue of timing metric education was well summarized by the Director of the Office of Education's Metric Education Program who stated: 1/

> "What the schools do and when will depend upon how fast other sectors of society move. Teachers who switch to international units may find they are beating their heads against a stone wall if their students have to deal in pounds, feet, and quarts everywhere but in school.
>
> "Our main job is to teach students the concepts of measurement and standards regardless of units. But it could be terribly confusing for young children to be faced with metric units in one class and customary units in another, or to work in metric in school and see and hear nothing but customary units at home, on TV, and in the stores."

Some State and local educators are preparing to teach metric. Many other sectors, however, don't know if or when they should convert. When or if the need for metric education as the predominant system will arise, no one knows. Timing then, is an issue which needs to be carefully coordinated.

Since 1972 about $7.3 million has been expended by the Office of Education and the National Institute of Education to support metric education. We know that education should precede usage. However, students should have opportunities to use metric skills to reinforce learning and prevent forgetting. It is possible that Federal funds, as well as State and local funds, are being prematurely expended to attain a goal which has not been yet established and is not likely to be achieved for some years.

It appears that before additional funds for metric education are considered, the education effort should be examined and put into phase with whatever metrication plans and efforts exist in industry, Government, recreation, merchandising, and other sectors.

1/ "The Inevitable Metric Advance," by Richard Elwell, American Education, U.S. Department of Health, Education, and Welfare, Dec. 1976, p. 6.

RECOMMENDATION TO THE CHAIRMAN, U.S. METRIC BOARD

We recommend that the Chairman ensure that State education agencies and the U.S. Office of Education coordinate the timing of metric conversion in education. This is needed so that metric instruction in schools will be in phase with the needs of the Nation in order that time, effort, and money will not be expended to develop and teach a predominantly metric program to students for a still nonmetric society. Educators must be reminded that U.S. policy at this time is voluntary which includes the option not to convert.

RECOMMENDATION TO THE SECRETARY OF HEALTH, EDUCATION, AND WELFARE

We recommend that the Office of Education be directed to clarify its publications and other communications regarding metric education to show that the U.S. policy is one of voluntary conversion and includes the option not to convert. It should also encourage schools to time their progress to predominantly metric instruction to conform to the conversion trends of industry, government, and other sectors in the communities where students will live and work.

APPENDIX I

U. S. GENERAL ACCOUNTING OFFICE

Metric Task Force
Survey of Metric Education

Instructions:

Please answer each of the following questions as frankly and completely as possible. We are interested in your views whether or not you consider yourself as knowledgeable as you would like. Responses on other's views need not be formal survey of their opinions.

There is space at the end of the questionnaire for any comments you may wish to make concerning the questionnaire, or any other related topics.

The questionnaire is numbered only to permit us to delete you agency's name from our list when we receive your completed questionnaire and thus avoid sending you an unnecessary followup request.

RESPONDENT INFORMATION:

Name: ______

TITLE: ______

TELEPHONE: ( ) ______
(Area code) (Number)

A. General Information:

1. What is the approximate student population in your state for each of the following grade groupings? (Please fill in the blanks.)

   Public schools K - 12 ______

   Private and parochial schools K - 12 ______

2. What is the approximate number of individual school districts in your state? (Please fill in the blank.)

   ______

3. Does your state have a mathematics curriculum developed by the state education agency? (Please check one.)

   [ ] Yes

   [ ] No—If "no", skip to question 5.

4. Which of the statements below best characterizes your state mathematics curriculum? (Please check one.)

   [ ] A curriculum suggesting guidelines from which school districts may develop their own curriculum.

   [ ] A curriculum setting forth requirements which must be taught uniformly throughout the state.

   [ ] Other (Please specify) ______

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5. In what parts of your state's education system could the state education agency legally require instruction in metric measurement? (Please check all that apply.)

- [ ] None
- [ ] Public schools, K - 12
- [ ] Private and parochial schools, K - 12
- [ ] Other (Please specify) ______________

B. Federal/State Laws and Policies

6. What is your understanding of the national policy concerning converting to the metric system? (Please check one.)

- [ ] No stated national policy
- [ ] Mandatory conversion within 10 years
- [ ] Federal coordination and planning of voluntary conversion
- [ ] A mandatory, gradual conversion (i.e., more than 10 years)
- [ ] No conversion
- [ ] Don't know
- [ ] Other (Please specify) ______________

7. If metric conversion occurs, which of the following roles, if any, should the Federal government assume? (Please check all that apply.)

- [ ] Plan the overall conversion
- [ ] Coordinate activities
- [ ] Establish target dates
- [ ] Counsel and advise interested parties
- [ ] Legislate the conversion process
- [ ] Make conversion mandatory
- [ ] Enforce the conversion process
- [ ] Other (Please specify) ______________
- [ ] None of the above
- [ ] No basis to judge

C. Support/Opposition to Metric Conversion

8. What is your understanding of your State education agency's opinion concerning the United States' conversion to the metric system? (Please check one.)

- [ ] Strongly support
- [ ] Somewhat support
- [ ] Undecided (the agency)
- [ ] Somewhat oppose
- [ ] Strongly oppose
- [ ] No basis to judge

9. Which statement below would you feel most nearly expresses the sentiment of most of the teachers in your State? (Please check one.)

- [ ] Teaching metric is a waste of time because the United States is a predominately non-metric country.
- [ ] Since the U.S.A.'s conversion to metric is inevitable, we must begin now to teach metric as the predominant system of measurement.
- [ ] We need to establish a balance between customary and metric instruction because our country will be using both kinds of measures for a long time.
- [ ] Other (Please specify) ______________

D. Measurement Education Policy

10. Which statement below most nearly expresses your State education agency's policy about measurement instruction? (Please check one.)

- [ ] Teach customary measurement only, except in some science and vocational and technical subjects when needed
- [ ] Teach customary measurement as the basic system in all grades and subjects with minor instruction in metric
- [ ] Teach customary and metric measurement with equal emphasis in all grades and subjects
- [ ] Teach metric measurement as the basic system in all grades and subjects with minor instruction in customary
- [ ] Teach metric measurement only in all grades and subjects
- [ ] Teach customary measurement as the basic system in the elementary grades and metric measurement as the basic system at upper grade levels
- [ ] Other (Please specify) ______________

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11. What provided the major motivation to the establishment of the State education agency's policy on measurement education? (Please check one.)

- ☐ Action by State legislature
- ☐ Action taken by State board of education
- ☐ Decision made by State governor
- ☐ Decision made by Chief State school officer
- ☐ Recent interest in and awareness of metric conversion
- ☐ Federal metric education activities
- ☐ Metric Conversion Act of 1975
- ☐ 1971 National Bureau of Standards Metric Study
- ☐ Other (Please specify) ____________

____

____

____

12. Does your State have a centralized textbook adoption policy? (Please check one.)

- ☐ Yes
- ☐ No (If "no", skip to question 14.)

13. In your view could your State education agency use textbook adoption as a means to control the growth of metric instruction in schools throughout the State? (Please check one.)

- ☐ Yes
- ☐ No

14. Has your State education agency established a target date for converting the instructional program in measurement from predominately English to predominately metric? (Please check one.)

- ☐ Yes
- ☐ No

If yes, what target date has been set? (Fill in the blank.) ____________

15. What is the status of the metric education program in <u>most</u> of the school districts in your State? (Please check one box in each row.)

	No action	Getting started	About half completed	Nearing completion	Completed
Planning and developing curriculum					
Orientation and training teachers					
Obtaining necessary teaching materials					

E. <u>Metric Instruction</u>

16. In approximately what percentage of the school districts in your state is metric measurement being taught? (Please check one box in each row.)

- ☐ In less than 1% of the school districts
- ☐ In 1% to 10% of the school districts
- ☐ In 11% to 25% of the school districts
- ☐ In 26% to 50% of the school districts
- ☐ In 51% to 75% of the school districts
- ☐ In more than 75% of the school districts

17. In teaching measurement in your State, how much emphasis is placed on metric instruction of the student groups listed below? (Please check one box in each row.)

	Major emphasis	Moderate emphasis	Minor or no emphasis	Not applicable
Grades K-3				
Grades 4-8				
Grades 9-12				

18. Approximately how much emphasis was placed on metric instruction of the student groups listed below 5 years ago? (Please check one box in each row.)

	Major emphasis	Moderate emphasis	Minor or no emphasis	Not applicable
Grades K-3				
Grades 4-8				
Grades 9-12				

19. How much will (or has) metric instruction change the present curriculum in the subject matter areas listed below? (Please check one box in each row.)

	A great deal	Some	Very little or not at all	Not applicable
Reading/Language Arts				
Social Studies				
Mathematics				
Physical and Health Education				
Home Economics				
Science				
Fine Arts				
Industrial Arts				
Vocational/Technical Ed.				
Business Education				

20. Which system - customary or metric - do you think students with no prior measurement skills can learn faster? (Please check one.)

- Customary - significantly faster
- Customary - slightly faster
- No difference
- Metric - slightly faster
- Metric - significantly faster
- No basis to judge

21. Do you agree or disagree with the following statement? (Please check one.)

"Metric is easier to learn; thus schools would have extra time to teach some of the new subjects now being introduced into the curricula."

- Agree
- Disagree
- No basis to judge

22. Approximately how long have most schools in your State been teaching some metric measurement as a regular part of the mathematics program? (Please check one.)

- Less than 2 years
- 2 to 5 years
- 6 to 10 years
- 11 to 15 years
- More than 15 years

23. How long do you think it would take to convert measurement instruction in the schools of your State from predominantly customary to predominantly metric? (Please check one.)

- Less than 5 years
- 5 to 10 years
- 11 to 15 years
- More than 15 years

24. If the schools in your State converted to predominantly metric instruction how long do you think there will be a need to continue some customary instruction? (Please check one.)

- Less than 5 years
- 5 to 10 years
- 11 to 15 years
- More than 15 years
- Indefinitely
- No basis to judge

25. Which, if any, of the statements below expresses the major problem faced by the metric education program in your State? (Please check one.)

- [ ] There is not enough time in the instructional schedule to add metric measurement to the curriculum.
- [ ] There is not enough money available to the schools to purchase the books and materials necessary to teach metric.
- [ ] The curriculum does not give adequate guidance, teachers don't know what they are expected to teach.
- [ ] Most teachers do not have the necessary knowledge and skills to teach metric.
- [ ] Good textbooks are not available.
- [ ] None of these is a problem
- [ ] Other (Please specify) ____________

____
____
____
____

F. Costs of Conversion

26. How (did, would) metric education affect normal costs for the activities listed below? (Please check one box for each row.)

	No effect	High additional cost	Moderate additional cost	Slight additional cost	Cost savings may result	Not applicable
Planning and curriculum development						
Teacher training						
Purchasing teaching materials						
Classroom instruction						

27. What, if any, Federal financial assistance to metric education has your State education agency received since 1970? (Please specify.)

____
____
____
____
____
____

28. Approximate the dollar amount of Federal financial assistance used since 1970 by your State education agency for metric education. (Please check one.)

- [ ] None
- [ ] Less than $10,000
- [ ] $10,000 to $24,999
- [ ] $25,000 to $49,999
- [ ] $50,000 to $74,999
- [ ] $75,000 to $100,000
- [ ] More than $100,000
- [ ] No basis to know

29. Approximate the dollar amount to State funds used for metric education since 1970. (Please check one.)

- [ ] None
- [ ] Less than $10,000
- [ ] $10,000 to $24,999
- [ ] $25,000 to $49,999
- [ ] $50,000 to $74,999
- [ ] $75,000 to $100,000
- [ ] More than $100,000
- [ ] No basis to know

30. Which of the activities below accounted for the largest expenditure of time and effort in your metric education program during the past 5 years? (Please check one.)

- [ ] Planning and curriculum development
- [ ] Teacher training
- [ ] Selecting and procuring teaching materials (textbooks, etc.)
- [ ] Classroom instruction
- [ ] Developing teaching materials
- [ ] Other (Please specify) ____________

____

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31. Which of the activities below has accounted for the largest expenditure of money in your metric education program during the past 5 years? (Please check one.)

- [ ] Planning and curriculum development
- [ ] Teacher training
- [ ] Selecting and procuring teaching materials (textbooks, etc.)
- [ ] Classroom instruction
- [ ] Developing teaching materials
- [ ] Other (Please specify) ________________

G. Potential Impacts of Metric Conversion

32. Listed below are several advantages frequently attributed to the metric system. Please indicate whether you agree or disagree that each would be a significant advantage for your State's educational program. (Please check one box for each row.)

	Agree	Disagree	No basis to judge
The metric system is easier to teach and would allow more time to teach other things			
The metric system is easier to learn and will result in fewer errors			
Metric measurement is more accurate			
Metric instruction helps student learn fractions easier			
The metric system will enhance students' achievement in scientific, vocational and technical subjects			
Other (Please specify)			

33. Listed below are several disadvantages frequently attributed to conversion to the metric system. Please indicate whether you agree or disagree that each would be a significant disadvantage for your State's educational program. (Please check one box for each row.)

	Agree	Disagree	No basis to judge
Conversion to the metric system will confuse students.			
Conversion to the metric system will confuse teachers with resulting loss of productivity.			
Staff retraining will be costly.			
Changing textbooks and other instructional materials will be costly.			
Metric measurement skills will be quickly lost because everyday activities are sill based on customary.			
Other (Please specify)			

34. For your State educational system, would the advantages of conversion to the metric system outweigh the disadvantages or vice versa? (Please check one.)

- [ ] Advantages significantly outweigh disadvantages
- [ ] Advantages slightly outweigh disadvantages
- [ ] Advantages would be about the same as disadvantage
- [ ] Disadvantages slightly outweigh advantages
- [ ] Disadvantages significantly outweigh advantages
- [ ] No basis to judge

35. If you have additional comments on any of the items within the questionnaire or related topics not covered, please feel free to express your views in the space below or attach additional data. We would be especially interested in receiving copies of laws, regulations, resolutions, state plans or other documents which establish State or local policy toward conversion to the metric system.

CHAPTER 25

MEDICINE AND RELATED AREAS

ARE ESSENTIALLY METRIC

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To understand the extent of metrication in medicine and related fields we looked at pharmaceuticals, professional services, hospitals, and medical supplies and equipment. Discussions with association officials and selected pharmaceutical manufacturers and members of the medical profession showed that in some of the areas, the metric system, but not necessarily the International System of Units, is used almost exclusively because of its suitability to the small measurements encountered. In other areas, particularly those which interface with the public, customary or a combination of customary and metric units are used.

PHARMACEUTICALS

In 1972 hearings before the Senate Committee on Commerce on a bill to make the metric system the official U.S. measurement system, one witness representing a pharmaceutical association stated that

> "Since the early 1930's American pharmaceutical manufacturers have been converting their operations completely to the metric system. This has been done to provide better and more uniform control and thus greater assurance of safety to consumers of drugs from possible error which might arise in converting between one system to another."

Information obtained from three pharmaceutical associations and a number of pharmaceutical manufacturers indicates that the industry basically has converted to metrics in some of its internal operations--formulation, production, and testing. In other areas customary or both customary and metric units are used.

The conversion to metrics appears to have caused little hardship. According to one manufacturer, conversion was easily accomplished and presented no great problems. He said some equipment, such as scales, was modified or replaced and formulas were recalculated. Two reasons given by the manufacturers for converting were:

--Pharmaceutical companies are scientifically oriented, and scientific disciplines have always used metric units.

--The use of metrics greatly facilitates communications with foreign manufacturers.

Although these manufacturers are using metrics, they are not using exclusively SI metrics. For example, one manufacturer is still using the millibar rather than the pascal as a measurement of pressure.

Customary measurements are still used in the packaging of prescription liquids sold in large sizes and nonprescription, or over-the-counter, drugs. In the former case, large containers of liquid drugs are sold to pharmacies which dispense them to the public in accordance with physicians' prescriptions. These prescriptions, in many instances, are written in metric units. In the latter case, the over-the-counter drugs are packaged in customary sizes for sale to the public. Sometimes these packages show only the customary size; other times they have a dual label, showing both the customary size and the metric equivalent.

The pharmaceutical industry also uses both customary and metric units in the acquisition of raw materials. The extent to which raw materials are received in customary or metric units appears to vary with the pharmaceutical company and the type of material.

Raw materials not designated in metric units are converted to metric when they are received. According to the manufacturers, this internal conversion does not seem to create great problems. One manufacturer told us he sees no advantage to receiving raw materials in metric units as the conversion is relatively simple; and even if he could, he would not require the suppliers to convert.

<u>Further metric activities</u>

The pharmaceutical manufacturers and associations saw no further metrication in the industry unless mandated. They saw no reason to convert the large volume liquid prescription drugs because there has been no customer demand for metric sizes.

With respect to converting the packaging of over-the-counter drugs to hard metric sizes, the manufacturers and associations recognized several problems.

Converting to hard metric sizes would require the manufacturer to adjust, modify, or replace equipment to fill metric containers. The extent of these adjustment modifications and replacements would depend on the product line, the sizes selected, etc. None of the companies could state what

the cost of further conversion might be, but they did believe it would be high and passed on to the consumer. They estimated that hard conversion would take from 2 to 15 years.

Another problem the manufacturers foresaw was the possible unavailability of containers. According to one manufacturer, the industry represents only a small part of the market for containers so costs would be high for a special order of metric containers.

One association official said the industry would tend to use dual labels rather than to hard convert. The industry is very competitive and has strong product identification; therefore, it would tend to avoid changes which might confuse its customers. He believed conversion would have to be made mandatory before the industry would move to hard conversion. The manufacturers supported this view.

Foreign trade

None of the manufacturers we talked to believed that further metrication would affect the amount of foreign trade in pharmaceuticals. One manufactuer said he saw no advantage to packaging pharmaceuticals for export. He feels it is too expensive and foreign licensing laws make it more advantageous to ship drugs in bulk to be packaged in the foreign country.

Although none of the manufacturers we talked to saw further metrication in the industry unless mandated or a significant advantage to further conversion, all believed metrication would benefit the country. They felt that metrication would facilitate comparison shopping and promote standardization and rationalization.

MEDICAL PROFESSION

The metric system is used extensively by the medical profession and has been for a number of years. It is used almost exclusively within the profession and in technical literature. Where the professions interface with the public, however, customary units of measure are more often used, particularly in recording and discussing body weight, height, and temperature, and in prescribing dosages of medication. Although the metric system is used, the SI metric units and symbology have not been fully integrated into operations.

The metric system appears to be particularly suited to the medical area because of the small units with which the profession must deal. A radiologist commented on the difficulty in describing a bone spur one or two millimeters long

in inch dimensions. He believed the fraction or decimal equivalent would be too cumbersome.

In this regard, the American Medical Association, in a 1972 letter to the Senate Committee on Commerce, stated that although the medical profession has almost completely adopted the metric system, total conversion must wait until the public learns and actively uses the metric system so that the patient and the physician can communicate in mutually understandable terms. The Association concluded that adoption of the system would improve scientific communications between physicians in America and those throughout the world and would benefit the advancement of scientific medical care.

An Association spokesman has, however, recently expressed some concern over the adoption of SI units. He said that there is little enthusiasm among practicing physicians to introduce new units that present no real advantage over the old units. He added that the only advantages are those that might accrue from the interchange between the medical science and other sciences that may be initiating the SI units. He also cited the possibility of errors arising from the confusion that will be introduced by using a new set of units. He said,

> "It is absolutely predictable that no matter how widespread the dissemination of the SI units may be, and no matter how carefully and how gradually the unit change is introduced, there will be confusion that will lead to errors, and perhaps serious consequences, including death, to the patient."

He concluded by saying that the medical profession can adjust to changes in units, but at some cost, and the changes should not be undertaken lightly. For this reason, he said the Council on Scientific Affairs has decided to establish an advisory panel to recommend the best course for the Association to take in its publications and in its recommendations to the rest of the profession.

Another doctor also has questioned the cost-benefit of changing to some of the SI metric units. He believed there would be a significant cost in terms of outmoded textbooks, delays in physician response time in converting from one system to another, and wasted forms. He further believed that no medical benefits have been identified from such a change.

HOSPITALS

Metric units, although not always SI, are used extensively in some hospital operations and have been for a long time. The use of metrics in these areas has been an evolutionary process in keeping with the scientific disciplines involved. In other areas, such as patient measurement, metric units are used to a lesser extent, although their use appears to be increasing. This increase may be an extension of the evolutionary process, but it has been given impetus by the belief that metric conversion in the United States is inevitable.

Conversion activities

To get some insight into the extent to which metric units of measure are being used in American hospitals and the extent to which further conversion is contemplated, we contacted a national hospital association and several hospitals across the country.

The association had little information on the number of hospitals converting, or the extent to which they have converted, to the metric system. A spokesperson, however, did say that hospital conversion is understood to consist of using metric units in recording all patient measurements, including temperature, weight, and linear dimensions; ordering and administering drugs and medicine; food service and dietary formulas; and reports and records. Conversion in other areas, he said, are doctor or industry related.

Information obtained from the hospitals showed little current conversion activity although two of the hospitals had completed a program to convert patient measurement several years ago. All of the hospitals indicated that many activities have been traditionally metric.

Patient measurements

At three of the four hospitals we contacted, the most recent conversion activity took place in taking and recording patient measurements and/or temperatures. The fourth hospital still uses customary units for these measurements. Two of the hospitals converted about 2 years ago when they began to use metric units for measuring patients' height and weight and the Celsius thermometer for taking temperatures. The conversions, which went fairly smoothly, were planned over periods ranging from less than a month to several months. Posters, news releases, hospital publications, and meetings with various departments were used to facilitate the conversion. The estimated cost of converting the scales at these

hospitals ranged from $46 to $60 for each scale. The cost of new thermometers was considered negligible as they are considered expendible property and are often given to the patients when they go home.

At the third hospital, conversion consisted only of taking and recording temperatures in Celsius. Patient weight is still taken in pounds and ounces although the weight of infants is taken and recorded in kilograms.

Spokespersons for the hospitals stated that conversion took place because they knew the metric system was coming and they wanted to be ready. Another reason given for converting at one of these hospitals was that it treated many foreign patients and had many foreign persons on its staff; thus, metrics made it easier to communicate.

In regard to converting from Farenheit to Celsius in taking body temperature, a doctor pointed out one possible problem area that might arise, particularly in the home. The public might not realize that a degree Celsius is almost twice as large as a degree Farenheit and might tend to underestimate the significance of a one- or two-degree Celsius rise in temperature by relating it to similar measure on a Farenheit scale. He believed the public should be made aware of the difference.

Dietetics and food service

Metrics are used to a limited extent in dietetics and food service. For example, at one hospital metrics are used in computing nutritional and caloric values of diets and in highly monitored tube feeding. Customary units are used when determining serving portions. The SI metric unit "kilojoule" is not being used to replace the calorie. The Chief of the dietetics department saw no particular advantage to metric conversion but noted that it might create some problems in training cooks and helpers. She has, however, introduced some informal training to make her employees aware of metrics in anticipation of metrication.

Other areas

Pharmacies, laboratories, surgery service, dentistry, and radiology are almost exclusively metric although some customary units may be used. Metric units seem particularly suitable in these areas because of the small quantities and dimensions used.

Although persons with whom we spoke stated that they used metric units to a great extent in their work, the units

were not always SI metric units. For example, none of these people used the SI unit of pressure, the "kilopascal." A surgeon said he was familiar with the unit through scientific literature but had never seen it used in any medical literature. A doctor in a clinical pathology laboratory said that other laboratories and hospitals currently do not use the same terminology and units to express test results, but the doctors who work with them know what these units are. He expressed some concern that if the SI units were adopted, it might cause considerable confusion between the laboratory and the physician. In addition, he saw no advantages to the change.

Our discussions concerning the extent of metrication of medical supplies and equipment with personnel at several of the hospitals indicated a "mixed bag." Catheters are designated in gauges and in inch lengths; surgical blades, by number; syringes are calibrated in metric units; and some measuring cups show milliliters, ounces, and drams. Foreign-manufactured X-ray machines have metric specifications, some with customary distance calibration, while U.S.-manufactured machines are in customary dimensions. X-ray film comes in both metric and customary sizes, and heart rate machine strip charts are in millimeters per second.

This mixture of measurements does not seem to create any great problems for those using the equipment or those servicing it. A surgeon said he identified surgical blades and sutures by number or gauge and really did not know what measurement they represented. A dentist said essentially the same thing with respect to dental drills. A biomedical engineer said that whether a machine was metric or customary in design or readout made little difference to him in servicing the machine or, as far as he could tell, to the person using it. He said he worked closely with medical personnel in selecting equipment and that quality, serviceability, and price were far more important than the measurement unit. He did believe it would be better if one system or the other were predominant.

CONCLUSIONS

Metric units of measure are used extensively in medicine and its related areas and appear to be particularly suitable because of the small measurements often encountered. Where the areas interface with the public, however, the customary units are more likely to be used. For some functions, such as recording patient weights and measurements, the customary units are being replaced by metric units. For other activities, such as labeling and packaging over-the-counter drugs,

it appears that mandatory conversion will be necessary before the customary sizes will be replaced.

While metric units are used extensively, the SI units have not been fully integrated into operations. When and if the units are adopted, their use initially may cause some confusion and result in errors.

CHAPTER 26

THE BEVERAGE INDUSTRY--A CASE STUDY

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The U.S. beverage industry 1/ provides a unique opportunity to see how metrication affects consumers and the industries that make consumer products. Other consumer product industries can benefit from the experiences of the beverage industry if the United States converts to the metric system.

Industry views on metrication varied. Some industry officials saw it as an opportunity to improve industry operations and benefit consumers. Others saw it as a costly change that would not benefit either the industry or its customers. Yet, still others said they would not convert unless forced to by the Government.

These views were affected by factors, such as exports, imports, marketability of products, competition, Federal and State laws, and the costs involved to adjust product containers to different sizes.

Some conversions made by the beverage industry have benefited consumers and the industry. But other conversions and related actions have been harmful to consumer interests.

Wines and distilled spirits are converting their products to metric sizes for marketing reasons. Both are regulated by the Department of Treasury's Bureau of Alcohol, Tobacco and Firearms; however, the producers requested the change. A considerable portion of their products are now being sold in metric sizes.

Several major soft drink producers have introduced metric sizes in many areas of the country. Following the favorable sales experienced by one producer, others saw an opportunity to increase sales. Producers also thought there would be an increase in the use of the metric system in the United States and, therefore, that new size introductions should be in metric. Some producers were showing metric equivalents on their customary-size products. But the soft drink industry did not plan an overall metric conversion in the near future.

Most milk containers show metric equivalents, but all milk is still sold in rational customary sizes. This industry had no plan to convert to metric sizes.

1/For the purposes of our study we looked into beer, distilled spirits, milk, soft drinks, and wine.

The beer industry sells all its products in customary sizes and did not plan to convert to metric sizes. Some brewers showed metric equivalents on their labels.

In carrying out our study, we discussed metrication with officials of beverage and container industry companies and associations and with government agencies in the United States and Canada. Pertinent documents were also reviewed.

WINES

The wine industry is converting its entire product line to metric sizes. As originally approved by the Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms, domestic wines were to be converted from 16 authorized customary to 7 metric sizes by January 1, 1979. The wine conversion period began January 1, 1975.

As the table below shows, only 9 of the 16 originally authorized customary sizes were in common use before the conversion. Thus, the effect of the conversion was to reduce the number of sizes the industry used from 9 to 7.

Sixteen customary sizes permitted until December 31, 1978			Seven metric sizes permitted after January 1, 1975			
Size	Equivalent fluid oz.	Percent sales before conversion	Size	Equivalent fluid oz.	Percent change from commonly used sizes	Ounce change from commonly used sizes
4.9 gal.	627.2	(a)	-	-	-	-
3.0 gal.	384.0	(a)	-	-	-	-
1.0 gal.	128.0	14.7	-	-	(b)	-
4/5 gal.	102.4	(a)	3.0 L	101.0	(c)	-
1/2 gal.	64.0	20.4	1.5 L	50.7	-20.8	-13.3
2/5 gal.	51.2	1.7	-	-	-	-
1 qt.	32.0	5.3	1.0 L	33.8	+5.6	+1.8
15/16 qt.	30.0	(a)	-	-	-	-
4/5 qt.	25.6	48.3	750 mL	25.4	-0.8	-0.2
1 pt.	16.0	3.7	-	-	-	-
4/5 pt.	12.8	4.3	375 mL	12.7	-0.8	-0.1
1/2 pt.	8.0	(a)	-	-	-	-
2/5 pt.	6.4	1.2	187 mL	6.3	-0.8	-0.1
4 oz.	4.0	(a)	-	-	-	-
3 oz.	3.0	(a)	100 mL	3.4	(d)	-
2 oz.	2.0	0.4				
Total		100.0				

a/Insignificant percentage of sales was made in this size.
b/No direct replacement was originally provided for the 1-gallon size. The 4-liter size, if used by producers as a replacement for the gallon, will contain almost 6 percent more contents.
c/The 4/5 gallon was not in common use. The 3-liter size, if used by producers as a replacement for the 1 gallon, will contain 21 percent less contents.
d/The 100 milliliter was used to replace the 2-, 3-, and 4-ounce sizes.

Subsequently, the Department approved the addition of 14 additional metric sizes. Under the change, use of containers in even liter amounts between 4 and 17 liters is permitted. Thus, the number of metric wine sizes permitted was increased to 21.

The conversion is being carried out under regulations prescribed by the Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms, which regulates the sizes in which wine products may be sold. However, it was the Wine Institute, a trade association representing California wine producers, that petitioned the Bureau to convert to metric sizes and reduce the number of permissible sizes.

In October 1971 the Bureau considered a Wine Institute request to make imported wines use the sizes domestic wines had to use. The Wine Institute made the request because many imported wines were being sold in bottles containing up to several ounces less than the 4/5 quart (the fifth--25.6 ounces), the most common size used by domestic producers. The bottles used for imported wines appeared to contain the same amount of contents as those used for domestic wines. The industry believed the practice was deceptive to consumers and gave foreign producers an unfair competitive advantage.

At a hearing held on the Wine Institute request, it was brought out that imported wines should not be required to use customary-size bottles because a National Bureau of Standards study had recommended that the United States switch to the metric system over a 10-year period. Subsequently, the Bureau denied the request because it considered it inappropriate to require foreign wine producers to use customary-size bottles for sales in the United States.

During 1973 the Wine Institute made a study of the metric wine sizes used by other wine producing nations. It selected a series of metric wine sizes for use in the United States, giving consideration to existing marketing practices in both the United States and other wine-producing nations. On October 3, 1973, the Wine Institute requested that the Bureau revise its regulations to (1) restrict wines to 6 metric sizes which would become mandatory after a 2-year period and eliminate the 16 customary sizes authorized for use, (2) impose the metric size requirements on imported wines, and (3) prescribe the number of bottles to be packed in a case of wine.

The Wine Institute selected the 750-milliliter (25.4 ounces) size as the primary size because it was very close to the 4/5 quart (25.6 ounces) which comprised about 48 percent of the industry's sales. The 750 milliliter was also used in

other countries. Four other metric sizes--the 3 liter, 1.5 liter, 375 milliliter and 187 milliliter--were selected by the Wine Institute because they were multiples or submultiples of the 750 milliliter and thus would enable consumers to make price comparisons between sizes. Selection of the 375 and the 187 milliliters also permitted continuation of sizes similar to those consumers and the industry were familiar with.

In June 1974 the Bureau held a public hearing on the proposal. All persons who spoke either openly endorsed the conversion of the wine industry or did not oppose it. Some persons, however, wanted sizes slightly different than those proposed by the Wine Institute. The Bureau also provided persons the opportunity to submit written comments. Of the 40 comments received, only three opposed converting to metric sizes.

In December 1974 the Bureau approved the wine conversion to seven metric sizes--the six requested by the Wine Institute plus the 100 milliter which had been requested by foreign wine producers, importers, and airlines to permit importation of sherries sold in one-person servings. The Bureau stated that the conversion would reduce the number of domestic wine sizes from 16 to 7 and the number of imported sizes from about 27 to 7. The Bureau also stated it should facilitate buyer comparison and unit pricing of wines by retail stores.

The Bureau provided for a 4-year conversion period beginning January 1, 1975. All wines, both domestic and imported, bottled after December 31, 1978, for sale in the United States are required to be in the authorized metric sizes. During the phasein period, producers who convert to metric sizes are required to show both the metric size and the fluid ounce equivalent on the bottles to help consumers during the conversion period.

A 4-year conversion period was selected to permit a more orderly phasein of new glass molds by permitting the replacement of existing glass molds as they wore out. The phasein period was selected after consulting with the glass industry. It was expected that a 4-year period would result in less cost to the wine industry and less disruption to the mold-making capacity of the glass industry. A 4-year conversion period was also expected to ease the burden of foreign wine producers which previously were exempt from the domestic size requirements and to provide consumers more time to become acquainted with the metric system and the new bottle sizes.

Requirements were also placed on the number of bottles permitted in a case. It was expected that use of uniform packing will benefit persons in the distribution chain, from

manufacturer to retailer, and will facilitate revenue collection by Federal and State tax officials.

- In April 1978, the Department approved the use of any container sizes between 4 and 17 liters that are in even liter amounts. It also exempted from the size requirements containers 18 liters or larger. Prior to the conversion there were no size requirements on wines sold in containers 5 gallons or larger. The Department had not previously adopted a metric size larger than 3 liters because in 1974, when the metric size proposal was being considered, almost no interest was expressed in larger sizes. Since adopting the metric sizes, one consumer and several industry members have requested that a 4-liter size be adopted to replace the gallon, and the Wine Institute has requested that 12- and 18- liter sizes be permitted.

Conversion progress

Conversion of the wine indus-try to metric sizes is about complete. Wine and glass industry officials we contacted were of the view that the conversion was progressing smoothly at little cost to the industries and little disruption to their operations. No significant problems were experienced by any of the organizations we contacted.

Conversion problems were eased because the 4-year conversion period permitted sufficient time for an orderly phasein of the new metric sizes and because the wine and glass industries made an informal agreement to convert on a size-by-size basis. The informal agreement permitted the industries to plan for an orderly conversion by considering the average life of glass molds used for wine bottles.

Glass molds for 4/5-quart bottles, the size in which nearly half of the wines were sold, were converted into 750-milliliter molds by making minor changes to existing mold sets at a cost of about $1,000 each. This permitted use of the mold sets through their normal life span. New mold sets would have cost between $10,000 and $20,000 each.

Several wine producers told us they simply ordered the new size bottles when they became available from glass companies and made minor adjustments to their filling equipment, and their conversion was virtually complete. One producer told us that purchases of new parts were needed to convert to the 3-liter size but that conversion costs were not considered significant. The producer added that this size change, the most difficult it had to make, required only about 1 hour.

Recordkeeping problems were common to most of the producers we contacted. Because tax payments were based on customary quantities, recordkeeping for wines sold in metric sizes had to be converted back to customary quantities. Problems arose over the way the Bureau of Alcohol, Tobacco and Firearms required producers to round sales' quantities. One producer told us that its computer system was not adaptable to the requirement. Bureau officials told us that most producers' problems occurred because computer programs could not be adjusted to the number of decimal places required in the regulations. The Bureau has made arrangements with 22 producers which had recordkeeping problems to permit them to base their tax computations on a fewer number of decimal places provided that the changes did not result in reductions in the amounts of Federal taxes that would have to be paid.

This recordkeeping problem would be eliminated if Federal taxes on wines were also converted to metric. Recordkeeping problems such as this could occur to other industries as well if they convert.

Impact on the wine industry

Wine producers generally were of the opinion that after the conversion to metric is complete, there will be little impact on production costs. One wine company official told us that about $12,000 annually in storage costs will be saved because one new shape, a 375-milliliter metric bottle, will be used to replace three, 4/5-pint bottles that the company previously used. Changes in other bottles could also result in some savings to the industry. These changes could have been made without converting to metric, but the metric conversion was viewed as providing the opportunity to make the changes.

During the conversion some costs were incurred as adjustments were made to production equipment, but these costs were not viewed as being significant. Employees adjusted to the changes. Several wholesalers and retailers we contacted said there was little impact on them.

Exports are not expected to increase

There is no firm indication that wine exports will increase because of the conversion, even though several of the sizes--750 milliliter, 1 liter, and 1.5 liter--were selected in part because they were among those approved for use in trade by the nations who belong to the European Economic Community. A Wine Institute official told us that tariff and nontariff barriers limited the increased export of American wines. There was no indication that container sizes were a problem for our wine exports before the conversion.

A Bureau official told us he did not expect that metrication would have a noticeable impact on either exports or imports of wines. However, he believed the United States would benefit in the long term as other nations would not be able to exclude American wines because the sizes did not meet international size standards. This would occur because the United States has adopted the metric sizes commonly used in world trade. The official also believed that the conversion was beneficial in that it established a climate of cooperation between the United States and the European Economic Community nations.

We noted, for example, that Canada also used its metric conversion of wine as an opportunity to bring imported wines under its newly established metric-size requirements. Because all of the metric sizes used in the United States are also used in Canada, size will not be a barrier for future exports to Canada.

Consumers receive limited benefits

Since five of the new metric sizes--187, 375, and 750 milliliters and 1.5 and 3 liters--are multiples of one another, it should be easier for consumers to make price comparisons between sizes. Consumers initially may not be aware that the numbers are multiples of one another because the size series is not in common use.

The liter of wine, however, will not be as easy for some consumers to make price comparisons with. It is one-third larger than the 750 milliliter. It was selected because it is a commonly used unit in the metric system and it is widely accepted in world trade.

The 100 milliliter will be more difficult to make comparisons with than the other sizes; however, little use will be made of this size, and consumers will feel little impact.

The addition of metric wine sizes in even liter amounts above 3 liters could cause a proliferation of container sizes, thus defeating one of the original aims of metrication. Also, sizes such as 4 and 5 liters cannot be easily compared in volume to other metric sizes, such as the 750 milliliter and the 1.5 and 3 liter, thereby defeating another of the original aims of metrication.

Consumers also should benefit because foreign wines will be required to be sold in the same sizes as domestically produced wines. Before the conversion the 4/5 quart comprised almost one-half of domestic wine sales. Many imported wines were in 23- and 24-ounce bottles which often appeared to have

the same quantity as domestic wines sold in the 4/5 quart (25.6 ounces). It is unlikely that most consumers were aware that the differences existed.

Consumers paid higher prices for metric wines

Consumers generally paid higher prices for domestic wines sold in metric-size bottles. As shown below, wine prices did not increase as much when bottle sizes remained the same as when they were converted to metric sizes or converted from the 1/2 gallon to the 2/5 gallon. The latter change was made in conjunction with the industry's replacement of the 1/2 gallon with the 1.5 liter.

Size used at January 1, 1976	Size used at January 31, 1978	Percentage price increase	Percentage change to metric sizes
1 gal.	1 gal.	6.2	
1 gal.	3 L	12.9	+6.7
1/2 gal.	1/2 gal.	6.7	
1/2 gal.	2/5 gal. or 1.5 L	17.2	+10.5
4/5 qt.	4/5 qt.	7.9	
4/5 qt.	750 mL	10.8	+2.9
4/5 pt.	4/5 pt.	12.4	
4/5 pt.	375 mL	12.0	-0.4

We analyzed two large marketing areas, Northern California and Montgomery County, Maryland, to see what changes were made to the prices consumers paid. We selected these areas because published information was available on the prices charged consumers.

For our detailed analysis we selected 19 wines sold by the Montgomery County Department of Liquor Control during 1976. The selections included the 10 domestic wines with the highest sales amounts in Montgomery County plus 9 other domestic wines with high sales volumes. The 19 wines, which were made by 9 different producers, comprised 37 percent of Montgomery County's 1976 sales. Seventeen of these wines were also sold in Northern California. We also analyzed the size and price changes made there so we could see whether the changes made in Montgomery County were also made elsewhere.

We obtained price lists from the Department of Liquor Control for the period January 1, 1976, through January 31, 1978, and for Northern California. The prices we analyzed were the prices charged consumers for wines in retail stores operated by the Montgomery County Department of Liquor Control. For Northern California the prices we analyzed were the minimum retail prices posted with the State by wine producers and distributors. We monitored the price and size changes made during these periods.

We looked into (1) the overall changes made to the wine prices and (2) the price changes made at the time the four most frequently used wine sizes were converted--the gallon, 1/2 gallon, 4/5 quart, and 4/5 pint.

We recognize that many factors affect the prices of the wines we selected which would cause the prices to change. In making our analysis we did not attempt to analyze all the factors involved in the establishment of the wine prices. Rather, we concentrated on the prices paid by the consumer in the marketplace to determine the impact the conversion had on the consuming public.

Introduction of the 3 liter

During the periods covered by our analyses, the 3-liter size--which is 27 ounces less than a gallon--was introduced for 10 wines that were being sold by the gallon. In each instance producers followed the practice of selling the 3-liter size at a lower price than had been charged for the gallon, but not making the price reductions sufficiently lower to make them proportionate to the size reductions. This practice resulted in increasing the unit prices at the times of the new size introductions an average of 10 percent--an average of 43 cents a bottle.

When the conversion period is over, wine sales in the gallon will no longer be permitted. In April 1978 the Department approved a proposal to permit metric sizes larger than the 3 liter. If a larger metric size, such as the 4 liter, is not selected to replace the gallon, the 3-liter size could be used.

Following is a schedule showing the price changes made to the 10 wines in Northern California and Montgomery County when the 3 liter was introduced.

Wine	Gallon bottle price	3-liter bottle price	Percent price increase based on contents	Monetary price increase per bottle based on contents
A	$5.99	$5.19	10	$0.46
B	5.75	5.19	15	.65
C	5.75	5.19	15	.65
D	5.39	4.79	13	.54
E	4.25	3.85	15	.50
F	5.49	4.38	1	.05
G	4.99	4.38	11	.44
H	4.99	4.38	11	.44
I	3.99	3.39	8	.24
J	6.49	5.49	7	.37
Average changes			10	$ .43

<u>High price increases accompanied conversions from the 1/2 gallon to the 2/5 gallon and the 1.5 liter</u>

The most significant price increases occurred in the conversion of the 1/2 gallon to the 1.5 liter. The manner in which the conversion was achieved is noteworthy. The nearest metric size to the 1/2 gallon (64 ounces) was the 1.5 liter (50.7 ounces) which contained almost 21-percent less contents.

Before the conversion the 1/2 gallon comprised about 20 percent of the industry's sales and the 2/5 gallon was only 1.7 percent of sales. When converting from the 1/2 gallon to the 1.5 liter, producers generally followed the practice of first converting wines from the 1/2-gallon size (64 ounces) to the 2/5-gallon size (51.2 ounces), a decrease in contents of 20 percent, and then converting from the 2/5-gallon size to the 1.5 liter, an additional decrease of 0.78 percent. Producers also generally followed the practice of reducing the 2/5-gallon price from that which was charged for the 1/2 gallon, but not making the price reductions sufficiently lower to make them proportionate to the size reduction.

Of the 24 wines we analyzed which were available in the 1/2-gallon size in Northern California and Montgomery County, 22 were converted to the 2/5 gallon or 1.5 liter by January 31, 1978. Fifteen of these converted from the 1/2 gallon to the 2/5 gallon, and seven converted directly from the 1/2 gallon to the 1.5 liter.

1.5 LITER 1/2 GALLON 2/5 GALLON

WHEN CONVERTING FROM THE 1/2 GALLON TO THE 1.5 LITER, PRODUCERS GENERALLY FOLLOWED THE PRACTICE OF FIRST CONVERTING WINES FROM THE 1/2-GALLON SIZE (64 OUNCES) TO THE 2/5-GALLON SIZE (51.2 OUNCES) AND THEN CONVERTING FROM THE 2/5-GALLON SIZE TO THE 1.5 LITER (50.7 OUNCES).

Following is a schedule showing the price changes made to the 15 wines in Northern California and Montgomery County when they converted from the 1/2 gallon to the 2/5 gallon. This practice resulted in increasing the unit prices at the time of the conversions an average of 17 percent--an average increase of 41 cents a bottle.

Wine	1/2-gallon bottle price	2/5-gallon bottle price	Percent price increase based on contents	Monetary price increase per bottle based on contents
A	$3.25	$3.09	19	$0.49
B	2.95	2.75	17	.39
C	2.95	2.75	17	.39
D	2.85	2.65	16	.37
E	3.65	3.35	15	.43
F	3.25	3.09	19	.49
G	2.75	2.59	18	.39
H	3.34	3.15	18	.48
I	2.79	2.59	16	.36
J	2.79	2.59	16	.36
K	2.49	2.39	20	.39
L	3.78	3.39	12	.37
M	3.34	3.15	18	.48
N	2.29	1.99	9	.16
O	3.49	3.39	22	.60
Average changes			17	$ .41

Nine of the above listed wines were later converted from the 2/5 gallon to the 1.5 liter. When the conversions to the 1.5 liter were made, no changes were made in the prices charged for a bottle. But, because the 1.5 liter (50.7 ounces) is almost 1 percent smaller than the 2/5 gallon (51.2 ounces) it replaced, the second size reduction increased the prices of the nine wines by an additional 1 percent--an additional increase of about 2 cents a bottle.

Following is a table showing the price changes made at the time the seven wines converted directly from the 1/2 gallon to the 1.5 liter.

Wine	1/2-gallon bottle price	1.5-liter bottle price	Percent price change based on contents	Monetary price change based on contents
A	$2.19	$1.99	+15	+$0.26
B	2.19	1.99	+15	+ .26
C	5.99	3.99	-19	- .76
D	2.59	2.35	+15	+ .30
E	2.69	2.35	+18	+ .22
F	2.49	2.35	+19	+ .38
G	3.65	3.39	+17	+ .50
Average changes			+ 7	+ .17

Thus, out of the 22 conversions that were made to eliminate the 1/2 gallon, only 1 resulted in a price decrease for consumers. All the others resulted in consumer price increases.

We looked into the price changes made in Montgomery County and Northern California throughout our analysis period and found that converted wines had higher average price increases. Prices of wines that were sold in the 1/2-gallon size increased an average of 6.7 percent. But, those that were converted to the 2/5-gallon or the 1.5-liter sizes increased an average of 17.2 percent. Thus, by January 31, 1978, consumers of converted wines were paying an average of 10.5 percent more than consumers who could still purchase wines that had not converted.

Bureau officials told us they had not expected the wine industry to convert to the 2/5 gallon as an interim size when converting to metric. They believed they had no way of preventing the industry from converting in this manner because the 2/5 gallon was an authorized customary size before the conversion.

The Bureau has no control over the prices charged for wines. A Bureau official told us he believed that consumer education would be the best solution for controlling any unwarranted price increases occurring during the conversion. The Bureau has done very little to help educate consumers on the size changes made by the wine industry which is regulated by the Bureau.

Conversions from the 4/5 quart to the 750 milliliter

During the periods covered by our analysis, 14 of the wines we analyzed in Northern Califormia and 15 of the wines we analyzed in Montgomery County converted from the 4/5 quart to the 750 milliliter. In 27 instances the 750 milliliter was introduced at the same price per bottle that the 4/5 quart had been sold, resulting in an average price increase of 0.8 percent--about 1 cent a bottle. The practice appears reasonable because there is only a 0.2-ounce difference in the two sizes, and the unit price change was small.

In one instance the 750 milliliter was introduced at a price 16 cents higher than had been charged for the 4/5 quart. In the other instance the 750 milliliter was introduced at a price 10 cents lower than had been charged for the 4/5 quart.

Conversions from the 4/5 pint to the 375 milliliter

At the beginning of our analysis period, 11 of the selected wines were available in the 4/5 pint. Nine of these were converted to the 375 milliliter.

In eight instances the 375 milliliter was sold at the same price as the 4/5 pint. The two sizes were nearly identical--the 375 milliliter is only 0.1 ounce less than the 4/5 pint. The size reduction amounted to an effective price increase of 0.7 percent--less than 1 cent a bottle. The practice appears reasonable because there is only a 0.1-ounce difference in the two sizes, and the price change was small.

In one instance the 375 milliliter was introduced 6 cents higher than had been charged for the 4/5 pint.

Throughout the analysis period, we found that converted wines had lower average price increases. Prices of wines that were sold in the 4/5-pint size increased an average of 12.4 percent. But, those that were converted to the 375 milliliter increased an average of 12 percent. Thus, by January 31, 1978, consumers of converted wines were paying an average of 0.4 percent less than consumers who could still purchase wines that had not converted.

Consumers were not provided adequate information

The wine industry and the Bureau have not taken sufficient steps to advise consumers about the wine conversion. Numerous advertisements for wines are contained in magazines

and newspapers. However, we observed only one instance where advertising was used to help inform the consumer about the size changes being made.

We asked four producers whether they planned any consumer education or advertising programs on the metric conversion. Only one producer had conducted any advertising specifically addressing the new sizes. The others told us they had no plans for acquainting consumers with the new sizes. One producer told us it believed the burden of advising the public about metric conversion rested with the Federal Government.

We believe it is particularly important for consumers to have adequate information during the period when the product sizes they are familiar with are being changed and more sizes than normal are on the market. We also believe informative advertising could have been used by the industry to advise the consuming public during the conversion period.

We also believe the Bureau has not adequately informed consumers about the metric conversion. In December 1974, when the regulation on converting wines to metric sizes was issued, the Bureau issued a press release on the conversion and the expected benefits.

In March 1977, over 2 years after the wine conversion began and many metric size wines were already in the marketplace, the Bureau began distributing the chart shown below.

DEPARTMENT OF THE TREASURY
BUREAU OF ALCOHOL, TOBACCO AND FIREARMS
WINE

BOTTLE SIZE	EQUIVALENT FLUID OUNCES	BOTTLES PER CASE	LITERS PER CASE	U.S. GALLONS PER CASE	CORRESPONDS TO
3 liters	101 Fl. Oz.	4	12.00	3.17004	4/5 Gallon
1.5 liters	50.7 Fl. Oz.	6	9.00	2.37753	2/5 Gallon
1 liter	33.8 Fl. Oz.	12	12.00	3.17004	1 Quart
750 milliliters	25.4 Fl. Oz.	12	9.00	2.37753	4/5 Quart
375 milliliters	12.7 Fl. Oz.	24	9.00	2.37753	4/5 Pint
187 milliliters	6.3 Fl. Oz.	48	8.976	2.37119	2/5 Pint
100 milliliters	3.4 Fl. Oz.	60	6.00	1.58502	2, 3, & 4 Oz.

Official Conversion Factor: 1 Liter = 0.26417 U.S. Gallon.
Mandatory date for conversion: January 1, 1979.

ATF F 5100.10 (9-76)

At the same time it issued the poster shown on the following page for placement in retail stores. The Bureau also issued a press release in which it advised consumers to be certain of the sizes they buy because of the potential for confusion between bottles of different sizes which appear to look alike. It cited the liter and the quart of wine as sizes which could be similar in appearance.

We believe the information provided on the chart and poster has been misleading to consumers. They show the 1.5 liter as replacing the 2/5 gallon, when actually the 1.5 liter is replacing both the 1/2 and 2/5 gallons. They show the 1.5 liter replacing a size only 0.5 ounce different; they do not show the 13-ounce difference between the 1/2 gallon and the 1.5 liter.

The poster and chart also do not show the 3 liter as replacing the gallon. They show the 3 liter as replacing the 4/5 gallon, a size that was authorized but used very little before conversion. They do not show the 27-ounce difference between the gallon and the 3-liter size.

Furthermore, the Bureau did not provide consumers sufficient information on how to make price comparisons between the new metric sizes and the customary sizes. It also did not advise consumers that five new metric sizes--187, 375, and 750 milliliters and 1.5 and 3 liters--are multiples of one another, a fact that may not be obvious to some consumers because the series is not used for other products.

Bureau officials were aware of the way the wine industry was converting from the 1/2 gallon to the 2/5 gallon and 1.5 liter. The Bureau should have advised consumers about this practice.

The Metric System for Wines

Comparing the New With the "Old" Bottle Sizes

NEW METRIC SIZES	APPROX. FLUID OUNCES	OLD U.S. SIZES	APPROX. FLUID OUNCES
100 ml	3.4	Miniature	2, 3 or 4
187 ml	6.3	2/5 Pint	6.4
375 ml	12.7	4/5 Pint	12.8
750 ml	25.4	4/5 Quart	25.6
1 Liter	33.8	1 Quart	32.0
1.5 Liter	50.7	2/5 Gallon	51.2
3 Liter	101	4/5 Gallon	102.4

Department of the Treasury   Bureau of Alcohol, Tobacco and Firearms

ATF P 5100.7 (12-76)

DISTILLED SPIRITS

The distilled spirits industry is also converting its entire product line to metric sizes. All distilled spirits are to be converted from 10 customary sizes to 6 metric sizes by January 1, 1980. Other items, such as cordials and liqueurs, which were exempt from the size requirements for distilled spirits, are also to be converted to the metric sizes.

The size reductions could have been achieved without metrication. At the time the industry made its request to convert to metric sizes, five of the customary sizes--1/2 gallon, quart, 4/5 quart, pint, and 1/2 pint--comprised 94 percent of the industry's sales, as shown in the table below. Except for the 4/5 quart, all the commonly used customary sizes were multiples of one another, making it easy for consumers to make price comparisons between most sizes. Eliminating little-used customary sizes also would have permitted the industry to reduce the number of distilled spirits sizes.

Principal customary sizes usable until December 31, 1979			Metric sizes permitted after October 1, 1976			
Size	Equivalent fluid oz.	Percent of total sales	Size	Equivalent fluid oz.	Percent change from commonly used sizes	Ounce change from commonly used sizes
1 gal.	128.0	0.1				
1/2 gal.	64.0	10.5	1.75 L	59.2	-7.5	-5.8
1 qt.	32.0	31.3	1.0 L	33.8	+5.6	+1.8
4/5 qt.	25.6	35.0	750 mL	25.4	-0.8	-0.2
3/4 qt.	24.0	0.8	-	-	(a)	-
1 pt.	16.0	8.7	500 mL	16.9	+5.6	+0.9
4/5 pt.	12.8	2.8	-	-	-	-
3/4 pt.	12.0	1.3	-	-	(a)	-
1/2 pt.	8.0	8.4	200 mL	6.8	-15.0	-1.2
1/8 pt.	2.0	-	-	-	-	-
1/10 pt.	1.6	1.1	50 mL	1.7	+ 6.3	+0.1
1/16 pt.	1.0	-	-	-	-	-
Total		100.0				

a/Size not authorized for distilled spirits. It was used for products, such as cordials and liqueurs, which were not restricted in size before the conversion.

Conversions of distilled spirits began October 1, 1976. Many products are currently being sold in the new metric sizes.

The conversion is also being carried out under regulations prescribed by the Bureau. However, it was the Distilled Spirits Council, a trade association which represents about 95 percent of the distilled spirits industry, that petitioned the Bureau for permission to convert to metric sizes and to reduce the number of permissible sizes. Among the reasons

given by the Council for wanting to convert were to (1) reduce production costs, (2) permit marketing and distribution efficiencies, (3) provide better service to the public, and (4) promote exports.

Several industry officials told us that elimination of two less profitable sizes--the miniature (1.6 ounces) and the 1/2 gallon--was the primary objective the industry sought by converting. They told us the industry was particularly interested in having the 1/2 gallon eliminated because it cost more to produce a 1/2-gallon bottle of distilled spirits than to produce 2 quarts. But, because consumers expected to pay less an ounce for larger sizes than for smaller sizes, the industry was forced to sell the 1/2 gallon for less than the price of 2 quarts.

Increasing popularity of the 1/2 gallon placed the industry in the position where a steadily increasing proportion of sales were moving into the less profitable 1/2 gallon. Elimination of the 1/2 gallon as part of a metric conversion would get the industry out of this awkward position.

The legislation by the Congress directing NBS to study metrication also stimulated the industry to consider converting to metric. By the early 1970s there was a feeling among some industry members that the United States would be converting. The industry was also influenced by the European Economic Community's selection in 1971 of 17 metric distilled spirits sizes for use in trade among member nations.

On December 10, 1973, the Distilled Spirits Council submitted a petition to the Bureau asking that a public hearing be held on the adoption of five metric sizes ranging in size from 250 milliliters to the liter. On March 11, 1975, the Council requested that the 1.75 liter be added to the list of proposed sizes. Some industry members had expressed interest in having a size larger than the liter.

On July 16, 1975, the Bureau published a notice in the "Federal Register" requesting public comments on the Council proposal to adopt six metric sizes--the 50, 187.5, 375, and 750 milliliters and the 1 and 1.75 liters. In the comments received, questions were raised by some persons on the proposed use of the 1.75 liter. It was contended that the 1.75 liter would not be in the consumers' interest because it was not easily comparable with other sizes under consideration.

Some persons suggested that the 1.5 liter be selected instead of the 1.75 liter. One reason given was that glass bottles in the 1.5-liter size were readily available. Other persons suggested that the 2-liter size be selected because

it was close to the 1/2 gallon and could be easily understood by consumers.

Bureau officials told us the 1.5 liter was not considered suitable because it was not sufficiently different from the liter and would not satisfy market needs for a size close to the 1/2 gallon. The Bureau and the industry have stated that the 2 liter was not practical because technological problems made it difficult to manufacture glass bottles in the 2-liter size. The technological problems appear to have stemmed from the industry's use of distinctive bottles for many individual products. The bottles frequently have special designs and handles which make them unique. The low volume required in the manufacture of individual bottles made it uneconomical to develop certain types of glass molds for large sizes. In contrast, the wine industry uses common bottles without distinctive designs, making it economical to make large-size bottles, such as the 1/2 gallon, the 3 liter, and the gallon.

On March 3, 1976, the Bureau approved conversion of distilled spirits to six metric sizes--the 50, 200, 500, and 750 milliliters and the 1 and 1.75 liters. Use of the metric sizes was authorized to begin October 1, 1976, and be complete by January 1, 1980.

The Bureau used the conversion as an opportunity to apply the size requirements to cordials, liqueurs, cocktails, highballs, bitters, and other specialty items that previously had been exempted. Requirements were also placed on the number of bottles permitted in a case.

In announcing the conversion, the Bureau Director said that the change "should result in positive benefits for consumers as well as for industry and government." He stated that the change to metric would (1) reduce significantly the number of bottle sizes, (2) provide enough separation between sizes to deter possible consumer deception, and (3) make calculations easier because of the round numbers. He also stated that these factors should aid consumers in making price comparisons. It was also expected that the conversion would benefit bottlers, glass manufacturers, wholesalers, retailers, and governmental agencies concerned with distilled spirits taxation and regulation.

<u>Industry views on conversion</u>

Conversion activities were just getting underway at the time of our discussions with five distilled spirits producers, the Distilled Spirits Council, and others in the industry. These officials, however, were not expecting any major problems or benefits. Several officials commented that they

expected some problems in having to maintain inventories of products in both sizes and that there would be some losses in productivity during the changeover.

One distilled spirits official described the conversion as posing no difficult problems for his company. He said that the company is constantly making changes in its operations. New bottles are introduced, new labels are developed, and production lines are adjusted to handle bottles of different sizes with varying contents. He viewed the change to metric as just another change; one not much different than his company faces on a day-to-day basis.

Another official of a distilled spirits producer told us that his company estimated it would cost $1.5 million to make the conversion. This includes converting bottle labels, making new glass molds, and changing equipment. Also included is the value of glass bottles made obsolete. This amount, however, was not considered substantial in that it amounted to less than 0.5 percent of the company's annual sales.

Another distilled spirits producer estimated it would spend $4 million to convert its facilities. Most of these costs would be for machinery adjustments to produce the 200 milliliter and 1.75 liter. The adjustments for these sizes were expected to be costly and time consuming because they were considerably different than the customary sizes produced. Only minor adjustments were considered necessary to convert to the 50, 500, and 750 milliliters and the liter.

This company also told us it would need to spend between $16,000 and $17,000 each for new glass molds for the new sizes. But, it questioned whether they should be considered metrication costs because with proper timing the new glass molds could be used to replace old ones that wear out.

Distillers did not expect there would be major changes in productivity because of the conversion. However, it was expected that some production, storing, and handling efficiencies would result because fewer sizes would be produced.

Overall, it did not appear that the industry was concerned with the conversion costs because these costs were not viewed as being substantial. On the other hand, the industry did not expect to realize any substantial benefits.

Exports are not expected to increase

None of the companies or trade associations we contacted expected exports to increase because of the conversion.

Tariff and nontariff barriers exist which restrict the export of U.S. distilled spirits.

Consumers will not benefit

We saw little evidence that consumers will benefit from the conversion of distilled spirits. Not all of the sizes selected make price comparisons easy for the consumer.

The 1.75 liter, which is replacing the 1/2 gallon, is not easily comparable with either the liter or the 750 milliliter, the sizes with which consumers will compare it. The 1.75 liter is 1-3/4 times larger than the liter and 2-1/3 times larger than the 750 milliliter. Consumers were better off when they could double the price of a quart or multiply the price of a 4/5 quart by 2.5 to determine whether the 1/2 gallon was a better value.

Bureau officials believed that even though it is not easy for consumers to make price comparisons with the 1.75 liter, its selection was better than the 2 liter. They believed it would not be in the consumers' best interests to force the industry to make an uneconomical size as the extra costs would have been passed on to consumers through higher prices. A Bureau official told us he was not overly concerned that consumers could not compare the 1.75 liter with the other sizes. He believed most consumers made price comparisons between items of the same size rather than between items of different sizes.

Before the conversion consumers could easily compare values between the 1/2 pint and the pint. Comparisons between their replacements, the 200 and 500 milliliters, will not be so easy because the 500 milliliter is 2-1/2 times larger than the 200 milliliter. Also, consumers will not be able to make easy price comparisons between the 200 milliliter and the 750 milliliter.

Bureau officials told us the 200 milliliter was selected because it was a size selected by the European Economic Community for use in international trade and because it falls in the 1-2-5 numbering series. Many metric proponents consider the 1-2-5 series an ideal size series for packaging consumer products because by using sizes, such as 200 and 500 milliliters and 1, 2, 5, and 10 liters, consumers can make price comparisons among sizes by multiplying or dividing by two and in some cases combined with a moving of the decimal sign.

Bureau officials told us they did not know how much international trade was conducted in the 200 milliliter or in the 1/2 pint which it replaced. Thus, they did not know what

the immediate impact on distilled spirits exports would be because the 200 milliliter size had been selected. They believed that the size selection was still valid because the potential for future exports would be facilitated.

Also, the desired benefit to the consumer of being able to make price comparisons between metric sizes because the 200 milliliter is in the 1-2-5 series will not materialize because the 750-milliliter and the 1.75-liter sizes are not in the series. Consumers will not be able to make all the price comparisons the Bureau sought.

Consumers paid higher prices for converted products

To see what changes were made to the prices consumers paid during the conversion period, we selected 28 distilled spirits sold in Northern California and 26 distilled spirits sold in Montgomery County, Maryland. In making our selections, we obtained distilled spirits sales data from the National Alcoholic Beverage Control Association, which gathers data on distilled spirits sales in 18 States and Montgomery County, Maryland. We selected distilled spirits which comprised about 35 percent of the sales of leading brands reported by the Association between January 1 and October 31, 1976.

We analyzed the price changes made to the selected distilled spirits for the period July 1, 1976--3 months before the conversion began--through January 31, 1978, to determine the impact of the conversion on the prices paid by the consuming public. The prices we analyzed were the prices charged consumers for distilled spirits in retail stores operated by the Montgomery County Department of Liquor Control. For Northern California the prices we analyzed were the minimum retail prices posted with the State by distilled spirits producers and distributors.

We recognize that many factors affect the prices of the distilled spirits we selected which cause prices to change. We did not attempt to analyze all the factors involved in the establishment of the distilled spirits prices. Rather, we concentrated on the prices charged in the marketplace to determine the impact the conversion had on the consuming public.

We found that consumers paid proportionately higher prices for products that were converted than for those which were not converted. Higher price increases were made to the 1.75 liter and the 200 milliliter--the sizes that consumers would have difficulty making price comparisons with--than for the other customary and metric sizes available for sale.

We looked into the overall price changes made between July 1, 1976, and January 31, 1978, and into the price changes that were made at the time of the conversions. The following schedule shows a comparison of the percentage price changes made between July 1, 1976, and January 31, 1978, to the distilled spirits sizes we analyzed.

Size used at July 1, 1976	Size used at Jan. 31, 1978	Percentage price change	Percentage change to metric size
1/2 gal.	1/2 gal.	-0.7	
1/2 gal.	1.75 L	+5.4	+6.1
1 qt.	1 qt.	+3.4	
4/5 qt.	4/5 qt.	+3.1	
4/5 qt.	750 mL	+3.8	+0.7
1/2 pt.	1/2 pt.	+2.0	
1/2 pt.	200 mL	+13.4	+11.4

No conversions were made from the quart to the liter, from the pint to the 500 milliliter, and from the 1/10 pint to the 50 milliliter. For these the metric sizes are all larger than the customary sizes they will replace.

The industry appears to be following the general practice of introducing first the metric sizes which are smaller than the customary sizes they will replace because it will most likely be necessary to increase the prices of the converted products. For example, officials at one distilled spirits company told us that because the liter is larger than the quart, price increases will be needed. Therefore, conversions from the quart to the liter will be made late in the conversion period. The price increases will make the liter prices appear to be less of a value than competitors' quarts that are also available for sale.

Consumers paid higher prices for distilled spirits converted from the 1/2 gallon to the 1.75 liter

Conversions from the 1/2 gallon to the 1.75 liter generally were the first made for the products analyzed. Of the 47 distilled spirits available in the 1/2-gallon size in Northern California and Montgomery County, 45 were converted to the 1.75 liter by January 31, 1978. In every instance, the product unit price increased. On the average, the price

increases made at the times of the conversions amounted to 4.7 percent--an average of 50 cents a bottle.

For 43 of the 45 conversions, the bottle price was decreased but not proportionate to the size decrease, resulting in an increase in the unit price. Making the price changes in this way made the prices of converted products appear cheaper than competitors' products that had not converted. For the other two conversions the prices of the smaller 1.75-liter bottles were increased over the 1/2 gallon being replaced. Because the 1.75-liter bottles look very similar to 1/2-gallon bottles, consumers who did not carefully look at the bottles could have been easily misled.

When we looked into the overall long-term price changes that were made in Montgomery County and Northern California between July 1, 1976, and January 31, 1978, we found that converted products had higher average price increases than those that had not converted. Prices of distilled spirits that were sold in the 1/2 gallon during the entire period decreased an average of 0.7 percent. But those that converted to the 1.75 liter increased an average of 5.4 percent. Thus, by January 31, 1978, consumers of converted distilled spirits were paying an average of 6.1 percent more than consumers who could still purchase items that had not converted.

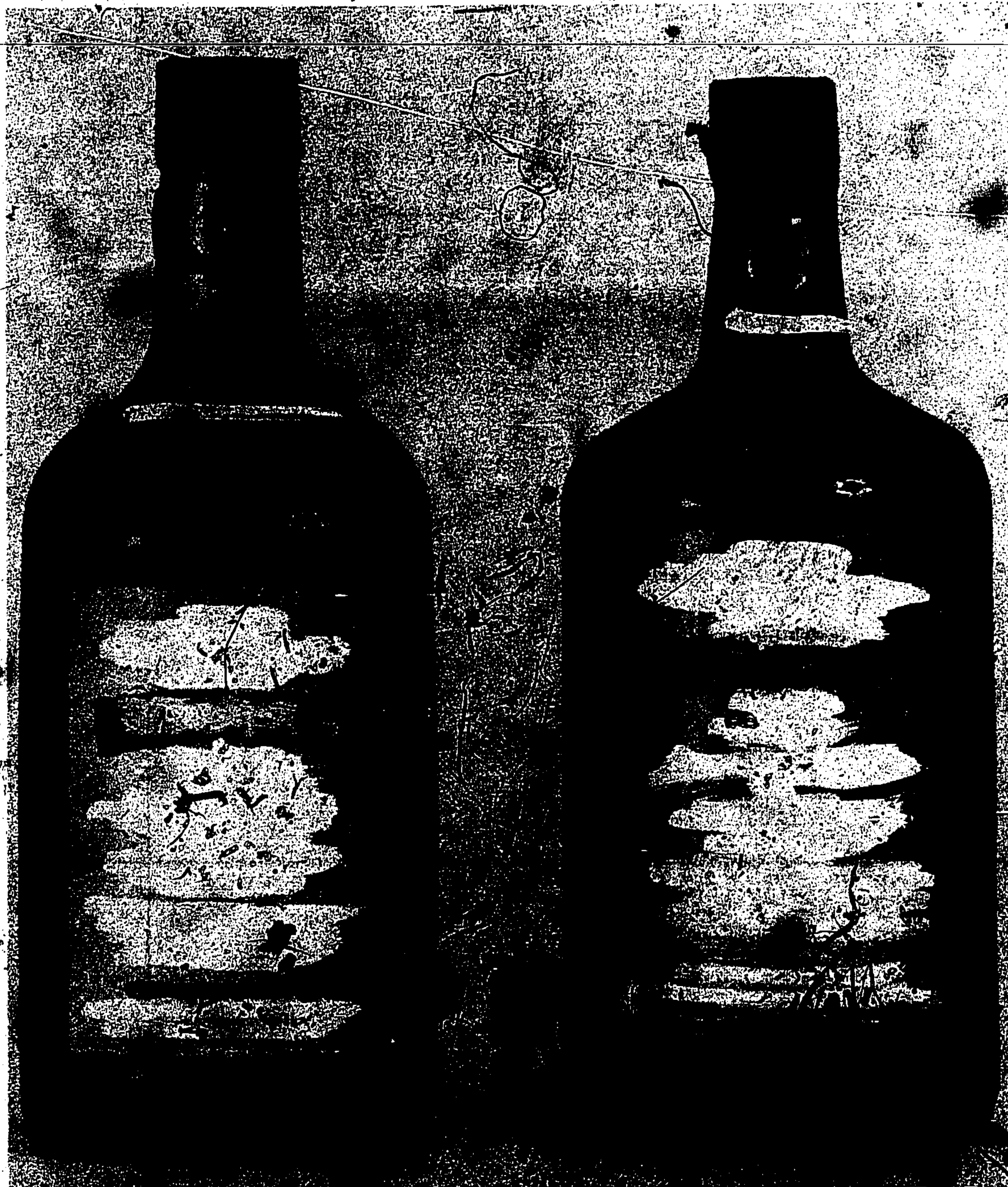
Conversions from the 4/5 quart to the 750 milliliter

By January 31, 1978, 34 of the 53 analyzed products in the 4/5-quart size were converted to the 750 milliliter. For 32 of the conversions, the 750 milliliter was sold at the same price that the 4/5 quart had been. In one instance the price was increased, and in another instance the price was decreased.

The 750 milliliter contains 0.2 ounce less contents than the 4/5 quart, a reduction of 0.8 percent. Conversions of the products we analyzed resulted in an average consumer price increase of 0.8 percent, about 4 cents a bottle. The practice appears reasonable because of the small size and price changes involved.

Conversions from the 1/2 pint to the 200 milliliter

Conversion from the 1/2 pint (8 ounces) to the 200 milliliter (6.8 ounces), a size decrease of 15 percent, represents the greatest percentage reduction in size being made to distilled spirits. By January 31, 1978, 38 of the 45 distilled



1/2 GALLON 1.75 LITER

BECAUSE THE 1.75 LITER BOTTLES LOOK VERY SIMILAR TO 1/2-GALLON BOTTLES, CONSUMERS WHO DID NOT CAREFULLY LOOK AT THE BOTTLES COULD HAVE BEEN EASILY MISLED.

spirits sold in the 1/2-pint size in Northern California and Montgomery County had been converted to the 200 milliliter.

For 33 of the 38 conversions, the prices charged for the smaller 200-milliliter bottles were lower than the prices that had been charged for the 1/2-pint bottles they replaced. However, the price decreases were not proportionate to the size decreases, resulting in increases in product unit prices. In the other five instances, the smaller 200-milliliter product was sold at the same price that was used for the 1/2 pint before it was converted. The average unit price increase made at the times of the conversions amounted to 10.8 percent--an average increase of 16 cents a bottle.

When we looked into the price changes that were made in Montgomery County and Northern California from July 1, 1976, to January 31, 1978, we found that converted products had higher average price increases than those that had not converted. Prices of distilled spirits sold in the 1/2-pint size during the entire period increased an average of 2.0 percent. But those converted to the 200 milliliter increased an average of 13.4 percent. Thus, by January 31, 1978, consumers of the converted distilled spirits we analyzed were paying an average of 11.4 percent more than consumers who could still purchase items that had not converted.

Cordials, liqueurs, and specialty items

The Bureau used the conversion of distilled spirits as an opportunity to require that cordials, liqueurs, and other special items produced by the distilled spirits industry also use the same metric sizes that distilled spirits were required to use. Before the conversion there was no requirement on the sizes of these products.

Consumers should benefit to the extent that size uniformity is established for these products. Consumers, however, may find the same difficulties making price comparisons between these products as they will for other distilled spirits in the new metric sizes.

Because of the wide variety of specialty items sold, we did not attempt to make price comparisons for the items which have been converted.

Consumers were not provided sufficient information

The distilled spirits industry and the Bureau did not take sufficient steps to inform consumers about the changes occurring in distilled spirits product sizes. Industry

producers place many advertisements in nationally distributed magazines, but we did not observe any instances where advertising was being used to inform consumers about the conversion.

In March 1976, when the Bureau announced the proposed conversion of distilled spirits to metric sizes, it issued a press release pointing out the differences between the sizes. In March 1977 the Bureau began distribution of the chart shown below to the industry and others who requested it, and the poster shown on the following page was distributed to distilled spirits plants, wholesale dealers, importers, and others, such as State liquor control agencies and retail stores.

DEPARTMENT OF THE TREASURY
BUREAU OF ALCOHOL, TOBACCO AND FIREARMS
DISTILLED SPIRITS

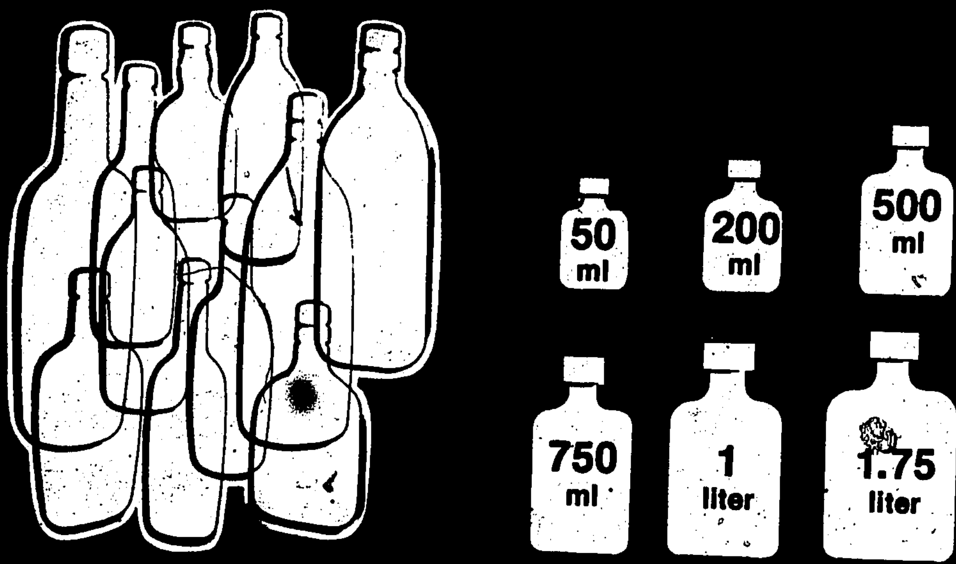
BOTTLE SIZE	EQUIVALENT FLUID OUNCES	BOTTLES PER CASE	LITERS PER CASE	U.S. GALLONS PER CASE	CORRESPONDS TO
1.75 liters	59.2 Fl. Oz.	6	10.50	2.773806	1/2 Gallon
1.00 liter	33.8 Fl. Oz.	12	12.00	3.170064	1 Quart
750 milliliters	25.4 Fl. Oz.	12	9.00	2.377548	4/5 Quart
500 milliliters	16.9 Fl. Oz.	24	12.00	3.170064	1 Pint
200 milliliters	6.8 Fl. Oz.	48	9.60	2.536051	1/2 Pint
50 milliliters	1.7 Fl. Oz.	120	[illegible]	1.585032	1, 1.6, & 2 Oz.

Official Conversion Factor: 1 Liter = 0.264172 [illegible]
Mandatory date for conversion: January 1, 19[illegible]

ATF F 5100.10 (9-76)

In March 1977 the Bureau also issued a press release in which it advised consumers to be certain of the sizes they buy because of the potential for confusion between bottles of different sizes which appear to look alike. It specifically called attention to the 1/2 gallon which contains 4.8 ounces more than the new 1.75-liter size but which may appear identical in appearance.

The chart and the poster will be of some assistance to consumers. However, we question whether they provided consumers with sufficient information needed during the conversion period. They list the new metric sizes with those that are being replaced, but do not show consumers the percentage differences between the new metric sizes and the customary



Confusion . . . to simplicity

the NEW! metric system

How do the new distilled spirits metric sizes compare with the current U.S. sizes?

METRIC SIZES	FLUID OZ. IN METRIC SIZES	CORRESPONDING U.S. SIZES	FLUID OZ. IN U.S. SIZES
50 ml	1.7 oz.	Miniature	1.6 oz.
200 ml	6.8 oz.	½ Pint	8 oz.
500 ml	16.9 oz.	1 Pint	16 oz.
750 ml	25.4 oz.	⅘ Quart	25.6 oz.
1 liter	33.8 oz.	1 Quart	32 oz.
1.75 liter	59.2 oz.	½ Gallon	64 oz.

Department of the Treasury
Bureau of Alcohol, Tobacco & Firearms

sizes--information that would be helpful to consumers desiring to make price comparisons during the conversion period.

We believe the Bureau should have been more aggressive in its efforts to help consumers.

FEDERAL TAXES ON WINES AND DISTILLED SPIRITS

Federal taxes on wines and distilled spirits are provided for in the Internal Revenue Code (26 U.S.C. 5001). These taxes are based on rates per gallon. Likewise, the Bureau's regulations on wine and distilled spirits taxes and other matters issued by the Bureau, except for those prescribing the wine and distilled spirits container sizes, are also based on customary quantities.

Producers must convert their sales records of metric products into customary measurement terms to determine their tax liabilities. As producers make conversions to metric, they must convert more and more of their records.

Recordkeeping problems were common with the wine producers we contacted. Several industry officials told us it would benefit their operations if the measurement system used for tax and statistical reporting were the same as that used for product sales.

Revisions of the Internal Revenue Code and related regulations will be needed if industry and Government recordkeeping is to be simplified.

SOFT DRINKS

Industry conversion activities

Use of metric size containers for soft drinks began in April 1975 when a major soft drink company introduced the liter size in one of its marketing areas. The company wanted to use the new bottle which, while shorter, would cost less since it contained less glass and would perform better on production lines. The new bottle would also permit a 20-percent savings in space for bottlers because (1) more cartons could be placed in the same amount of space, (2) increased payloads would be possible for trucks, and (3) more storage capability would result in warehouses. Also, customers preferred the new bottle.

The company was concerned that the low height of the new bottle would be perceived by customers as containing less quantity than competing products. The company believed it could overcome the height perception problem by designing the

new bottle to contain more contents than competing products and convincing customers that the shorter bottle actually had more contents. The liter was selected because it contained 1.8 ounces more than the quart, and there had been national interest in metrics.

The company viewed using the liter as an opportunity to be the first in the soft drink industry with the metric system. Besides, if the company converted to metric it would need to have a bottle that was different from the standard size and shape to solve potential sorting problems in bottling plants.

Timing also was considered right for introducing a liter size. Larger sizes, specifically the quart and the 1/2 gallon, were becoming more and more important in industry sales, so it made sense to introduce the metric size in a large bottle. Also, in most marketing areas, the larger bottle would be an addition to the company's existing sizes rather than a replacement for an existing size.

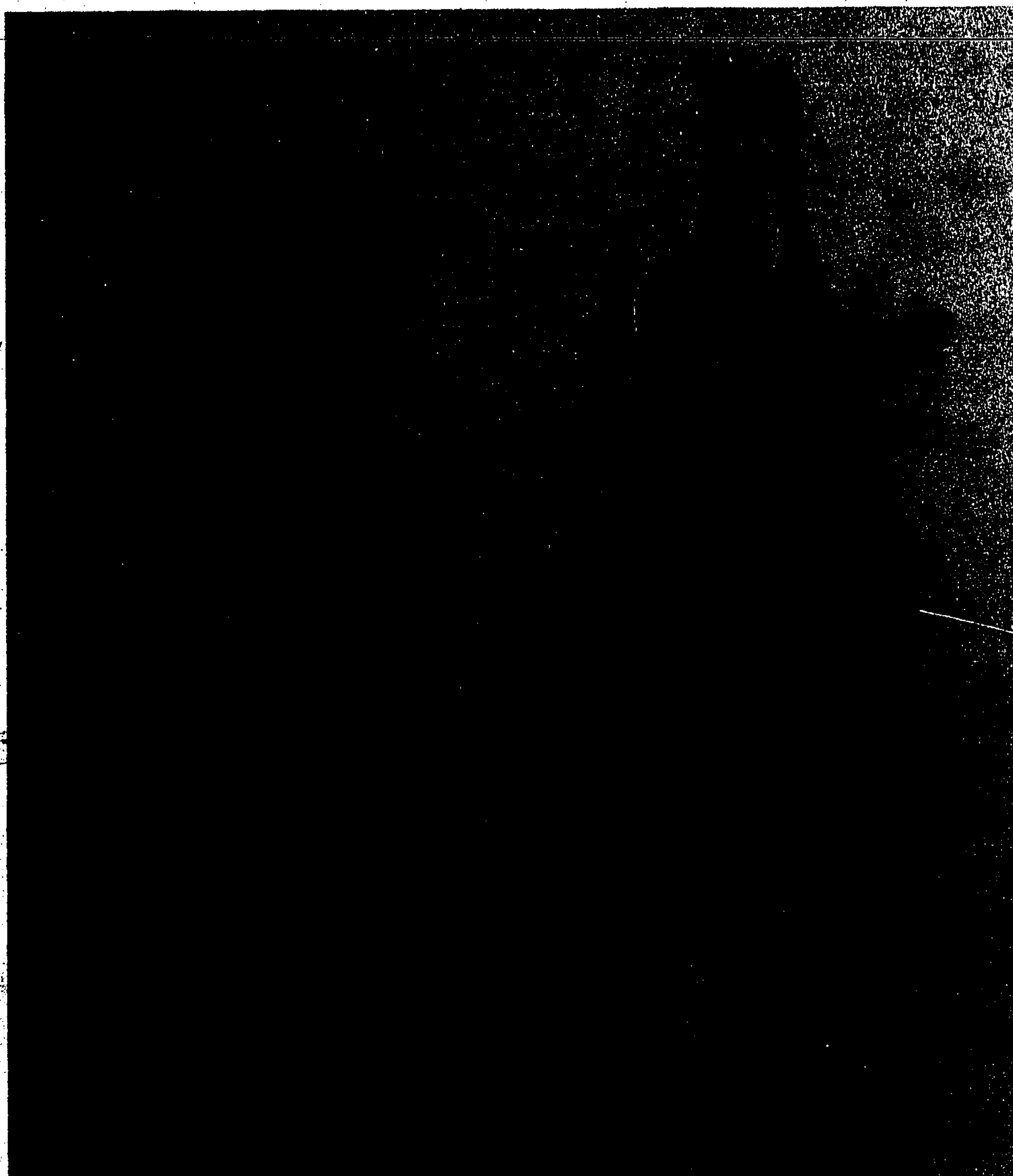
Introduction of the new size in the first marketing area was considered a success. Sales were high. The size introduction was accompanied by an extensive advertising campaign. Also, the news media gave the new size extensive coverage, which resulted in a form of free advertising.

Because of the successful sales experienced in the first marketing area, bottlers in other areas also began to use the liter size, and the company also began use of the 1/2-liter and the 2-liter sizes. Both refillable and nonrefillable metric-size bottles were used.

Since April 1975 use of metric sizes by the soft drink industry has become widespread. One company estimated in March 1977 that over 60 percent of the United States had at least one of its metric-size bottles.

All the metric soft drink changes that we are aware of involved soft drinks sold in bottles. No soft drinks were being sold in metric-size cans. Soft drink industry officials told us that no conversions involved cans because the costs to convert can production facilities would be too high, about $1 million for each can production line. Also, concern was expressed on the impact changing can sizes would have on vending machines.

We did not identify any instances where the new metric sizes were not used to replace existing customary sizes sold in refillable bottles. About 38 percent of the industry's 1975 sales were in refillable bottles and to replace them



THE COMPANY WAS CONCERNED THAT THE LOW HEIGHT OF THE NEW BOTTLE WOULD BE PERCEIVED BY CUSTOMERS AS CONTAINING LESS QUANTITY THAN COMPETING PRODUCTS.

with new metric sizes could be costly for the industry. One soft drink company told us it would cost $66 million to replace its existing inventory of customary-size refillable bottles, related equipment, and bottle cartons. Another soft drink company told us it would cost over $100 million just to replace the bottle inventory of two of its key sizes.

Regarding refillable bottles, in 1971 the Oregon State Legislature enacted a minimum deposit law that required that a refund be paid on all beverage containers. By early 1977 four States and several local governments had enacted some type of mandatory deposit legislation. Other jurisdictions are considering similar requirements, and suggestions have been made to enact Federal legislation providing for a national mandatory deposit system. It is expected that enactment of mandatory deposit legislation would cause the use of refillable containers to increase. If this happens soft drink bottlers will need to purchase larger inventories of refillable bottles than are currently needed. If their inventories of customary-size refillable bottles increase, conversion may be more difficult.

All the industry's metric activities have been made on a voluntary basis. Industry officials viewed conversions to metric on a voluntary basis as best serving the industry's needs. They believed that by being able to convert on a voluntary basis, changes can be made when most beneficial to their operations. Changes made in this manner were expected to be less costly.

Officials generally expected that use of metric-size containers will continue to increase. However, the industry has no timetable for making a conversion to metric sizes. One official estimated that, unless unforeseen marketing changes occur, its most widely used refillable customary bottle size would still be in use for 20 more years.

In spite of the successes achieved by the industry in adopting metric-size containers, industry officials told us of no specific benefits the industry would obtain by making greater use of the metric system. Benefits, such as the introduction of new shape bottles and achieving sales increases by selling products in containers larger than those used by competitors, could have been achieved without converting to metric.

Soft drink industry officials told us that bottled soft drinks are not exported. A conversion to metric was not expected to have any effect on exports.

Consumers have benefited

It appears to us, however, that consumers have received some benefits from the size changes in the soft drink industry. The soft drink industry has begun marketing some of its products in rational metric sizes, which, if this trend continues and a complete conversion is made to metric sizes, should help make price comparisons easier for consumers. In February 1977, the Virginia Department of Agriculture and Commerce reported in its monthly newsletter of consumer information that several soft drink bottlers had converted soft drinks in certain areas to larger metric sizes without increasing the price. For example, one company that had sold its soft drinks in a 28-ounce, nonrefillable bottle began selling the liter (33.8 ounces) at the same price. Other companies had sold the liter at the same price that had been used for sales of the quart (32 ounces), giving consumers almost 6 percent more value for their money. One company told us its pricing strategy was to price the liter at the same price as competitors' quarts. We were not able to verify the actual pricing of soft drinks that has occurred as bottlers made conversions into metric sizes.

Consumers have also benefited in that the metric sizes used by the soft drink industry--1/2 liter, liter, and 2 liter--are multiples of one another. Use of these sizes permits consumers to make price comparisons between these sizes while at the same time providing sufficient choice to satisfy consumer needs. Increased use of these sizes could result in even further benefits to consumers desiring to make price comparisons when shopping.

Soft drinks are sold in 15 customary size containers--6-1/2, 7, 8, 10, 12, 16, 24, 26, 28, 30, 32, 36, 48, and 64 ounces. Many of these sizes do not lend to easy price comparisons with other sizes. Also, many soft drinks are sold in cartons having 2, 4, 6, 8, or other quantity containers. Because of this, the soft drink cartons consumers purchase come in sizes such as 39, 42, 96, and 128 ounces--quantities which which do not lend to easy price comparisons.

If there were a complete conversion to metric sizes, this could help facilitate consumer price comparsions, particularly if rational sizes like the 1/2 liter, liter, and 2 liter are used. For example, the price of a carton of eight 1/2-liter bottles (4 liters) could easily be compared with the price of four 1-liter bottles or two 2-liter bottles. The same advantage could be achieved, however, if soft drinks were sold in customary sizes that were multiples of one another. Also, the benefit of rational sizes is not as important when stores use unit pricing labels. (See ch. 27.)

Most milk containers show metric equivalents. This practice began in the early 1970s when the industry was required to change the labels to show nutrients. The decision to show metric equivalents was made in response to an NBS suggestion that the milk industry convert to metric.

The sizes in which milk may be sold is strictly regulated by various State laws. At present, the 1/2 pint, pint, quart, 1/2 gallon, and gallon are the most commonly used sizes. They are all multiples of one another which makes price comparisons for consumers simple. Other sizes permitted include the gill, an amount equal to about 1/4 pint, and 3 quarts. The 3-quart size is permitted in about 20 States but is not widely used.

The States have not approved the sale of milk in metric sizes. However, proposals have been introduced at the National Conference of Weights and Measures, an annual conference of weights and measures officials, to permit use of certain metric sizes for milk. The proposals have not yet been approved.

A Milk Industry Foundation official told us he did not expect conversion of the milk industry to result in any benefits for consumers. The official did not know what impact conversion of product sizes would have on industry costs. No studies have been made to determine what these costs would be.

Very little liquid milk is exported. An industry official told us that conversion to metric would not have any impact on international trade of milk. Also, it is not expected that conversion of the milk industry would reduce the number of sizes produced. It appears that if conversion occurs, the most frequently used metric sizes would be as follows.

Metric size	Existing customary size
250 mL	1/2 pint
500 mL	1 pint
1 L	1 quart
2 L	1/2 gallon
4 L	1 gallon

Each of the above metric sizes is about 6 percent larger than the customary size it would replace.

Industry representatives did not see any benefits in converting its containers to metric sizes. The industry did not expect that any production or marketing efficiencies would result if it were to convert. It has vigorously opposed any metrication efforts that would make its container sizes obsolete. Several producers show metric equivalents on product labels, but no conversions have been made to metric-size containers.

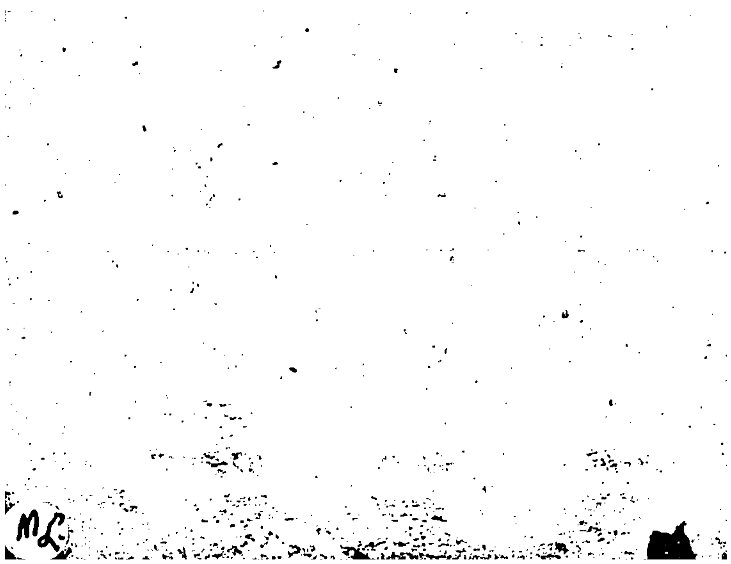
The sizes in which beer is sold is regulated by the States and many different sizes are authorized. Under the Federal Alcohol Administration Act, the States are provided the authority to regulate beer sizes. The sizes most widely used are 7, 12, 16, and 32 ounces. Revisions of laws in many States would be necessary if the industry converted to metric sizes.

A U.S. Brewers Association official told us that conversion to metric sizes would not increase exports. Most overseas beer shipments are to our military forces. Very little beer is exported to other countries. Tariff and nontariff barriers would still limit beer exports. Also, the high cost to ship beer overseas makes its sale noncompetitive in foreign markets.

In 1975, 16 percent of beer sales were in refillable bottles, and the industry has a sizeable investment in refillable bottles, most of which are 12 ounces. The industry says these would be expensive to replace with metric-size bottles.

Industry officials told us it would be costly to adjust can-filling lines to accommodate metric sizes. At one company officials estimated it would cost $1.5 million to adjust each can line--a total of $15 million to change its canning facilities. In 1975, 61 percent of the industry's sales were in cans. Many beers are now sold in 12- and 16-ounce cans. Most production lines for filling cans are not easily adjustable to handle different sizes.

Several industry officials believed it was inevitable that the industry would convert to metric. But, they believed conversions would not occur for many years unless required by the Government. Two industry officials told us they expected that a producer would convert to metric when it saw a marketing advantage to making the change and this would stimulate others to convert. Industry officials believed that the United States should continue a voluntary policy of converting to the metric system.



The substantial use of refillable bottles and cans has caused great concern within the beer industry on the impact converting to metric sizes would have. Soft drink industry officials had similar views on the impact of converting can sizes and existing inventories of refillable bottles. These concerns were not felt by the wine and distilled spirits industries because they use one-way, nonrefillable bottles.

BEVERAGE CONVERSIONS IN CANADA

Our discussions with Canadian officials revealed some differences and similarities in views and techniques on converting products to metric sizes. Their views also illustrate what we may expect to occur in the United States if other products convert.

The wine conversion in Canada is being carried out in a manner very similar to the conversion in the United States. The Canadian wine industry has adopted the same metric sizes that we have, plus the 500-milliliter and 2-liter sizes that we do not have. The Canadian wine industry believes it has benefited from the conversion because it used the change as an opportunity for producers to make greater use of stock bottles (bottles made by the glass industry for use by more than one producer).

Little progress has been made in converting the Canadian distilled spirits industry. The industry and government agencies had difficulties reaching an agreement on new metric sizes. The industry did not want to change product sizes because it would need to have new glass molds made.

The Canadian soft drink industry is replacing its entire inventory of refillable bottles with new, metric-size, refillable bottles. The conversion is being carried out over an 8- to 10-year period so that the existing customary-size bottles can be used through their normal life span. Metric-size, refillable bottles are being purchased as needed to replace bottles that have not been returned to the soft drink companies or cannot be reused. The long conversion period was agreed on to minimize conversion costs. Soft drinks were not sold in nonrefillable bottles. No changes will be made to the 10-ounce can size--the only size used for soft drinks--because of the high costs that would be involved.

Conversion of milk containers is well underway, although there have been delays in Ontario Province. Initially there was considerable industry reluctance to converting.

Milk producers' problems varied by the type of packaging used. Most milk was sold in plastic pouches, and we were told

that producers had little trouble converting those production facilities. But producers who used paper cartons claimed that production costs rose. We were told that producers using paper cartons needed to purchase much new equipment in order to convert but that the new equipment was technologically better than the old production equipment, resulting in efficiency improvements. The old equipment was designed to place milk in Imperial-quart (40 Imperial ounces) cartons and could not be easily converted to produce milk in liter cartons.

Milk sales increased after the conversion. It was believed this occurred because the widely used 3-quart size (120 Imperial ounces) was converted to a 4-liter pack (141 Imperial ounces). A Canadian milk industry official told us he believed milk sales in the United States might also increase if a conversion to metric sizes was made because the liter is about 6 percent larger than the quart.

No changes were being made to the beer container sizes used in Canada. Over 90 percent of beer sales were in 12-Imperial-ounce refillable bottles. The industry was not asked to change its bottle size because considerable costs would be incurred and no benefits would be gained. Very little beer was sold in cans, and the can size will not be changed.

CONCLUSIONS

Metrication will require vigilance at all levels of government. Protection of the consumer is not the responsibility of any one level--it is a responsibility of both industry and government. If the United States converts, special precautions will need to be taken during the conversion period to ensure that the consumer is adequately protected and assisted when the need arises.

Metrication proponents have stated that consumers will benefit if rational package sizes are adopted which would make price comparisons easier. However, our study of the beverage industry showed that conversion to the metric system does not necessarily provide assurance that consumer products will be manufactured in sizes that will be easier for consumers to understand and make price comparisons between. Certain wine and distilled spirits sizes, such as the quart and 1/2 gallon, were easier to understand and make price comparisons with than some of the metric sizes selected.

The addition of larger metric wine sizes to those originally permitted shows that objectives sought which were to benefit the consumer--reduction in the number of sizes in use and the establishment of sizes which can be used in making value comparisons--may be lost through later actions by those

involved. The metric sizes which come into use may not be any more understandable to consumers than the customary sizes were.

Many beverages have traditionally been sold in rational customary sizes. Milk is already sold in rational customary sizes, and rational customary and metric sizes have been placed into use by the soft drink industry. While further adoption of rational package sizes is a laudable objective for beverages, it is one that can be achieved without converting to the metric system.

Conversion to the metric system does not assure that consumers will benefit. The soft drink industry has made changes that have provided some benefits for consumers. Rational sizes have been selected, and the information we obtained indicated that prices were not increased. But the distilled spirits and wine conversions generally resulted in consumer price increases.

Conversion of the wine and distilled spirits industries was facilitated because the sizes of these products are regulated by one Government agency. Milk and beer sizes are also regulated, but size regulation is performed by each State. If milk and beer are to be converted to metric sizes, coordination among the States will be desirable. Soft drink sizes are not regulated. Improvements are possible to the sizes now used for soft drinks and some changes may be desirable, but conversion to metric sizes could result in adoption of new sizes which do not benefit consumers.

Many additional beverage producers will not convert unless required to do so by the Government or in the event of unforeseen marketing forces. Some beverage producers' actions have been influenced by the belief that metric conversion is inevitable.

The conversion periods used for converting wines and distilled spirits were adequate to meet the needs of these industries and of the glass industry which supplies the bottles used. The wine and distilled spirits conversions have shown that selection of proper conversion periods helps to reduce conversion costs.

If the United States converts, consumers will benefit if products are converted in short time periods. This will eliminate using two measurement systems in the marketplace for a long period of time. Yet, an adequate period of time is needed to minimize conversion costs. The needs of both would need to be balanced.

The Department of the Treasury's Bureau of Alcohol, Tobacco and Firearms should reevaluate the metric sizes selected for distilled spirits. The 200-milliliter and the 1.75-liter sizes selected for distilled spirits do not provide consumers ease of price comparisons. It was in these sizes that the highest price increases occurred when metrication took place. Similar price increases occurred in metric wine sizes where significant size changes occurred.

During the periods we observed, producers generally converted first to smaller-size bottles. Both the price and the contents of the bottles were reduced. However, the reductions were not proportionate, resulting in unit price increases. Producers have deferred making conversions to larger metric sizes. Wines and distilled spirits that were converted to metric sizes experienced unit price increases greater than for those that did not convert.

While the impact of the wine and distilled spirits conversions on consumer prices has been largely detrimental so far, it remains to be seen whether the practice of increasing prices of converted products continues through the rest of the conversion periods.

The Bureau and the wine and distilled spirits industries, in carrying out the first complete national metric conversion of a consumer product, had a unique responsibility to adequately inform consumers of the changes. The industries requested the Bureau's approval to convert to metric sizes, and the Bureau gave its consent. These organizations have not adequately advised consumers about the size changes being made.

As a Government agency responsible to the public, the Bureau should have ensured that its actions protected the public interest. Because it did not do this, consumers were not adequately served. The Bureau should expand its public awareness program to better inform consumers about the size changes being made.

The wine conversion caused recordkeeping problems. Recordkeeping problems also should probably be expected for other products during any transition period from the use of customary to metric sizes, and eventually the need will arise to decide whether to make metric the predominant measurement system. For the wine industry, recordkeeping problems caused by the conversion could be alleviated if the Bureau's tax and reporting requirements were also converted to metric.

RECOMMENDATIONS TO THE SECRETARY OF THE TREASURY

In view of the difficulties in converting the wine industry's records into customary units for the purpose of determining Federal tax liabilities and the likelihood that similar problems will occur in the distilled spirits industry, we recommend that when appropriate the Secretary request that the Congress amend the Internal Revenue Code to tax wines and distilled spirits on the basis of metric quantities.

To ease the wine and distilled spirits industries' recordkeeping burden, the Secretary should review the Bureau's statistical reporting requirements and convert them to metric when appropriate.

The Secretary should also expand its public awareness program to better inform consumers about the size and price changes being made to wines and distilled spirits.

The Secretary should require the Director, Bureau of Alcohol, Tobacco and Firearms, to reevaluate the metric-container sizes adopted for distilled spirits. Specific consideration should be given to replacing the 1.75-liter and the 200-milliliter sizes for distilled spirits with sizes which would facilitate price comparisons consistent with consumer needs.

AGENCY COMMENTS AND OUR EVALUATION

On July 6, 1978, we met with Department officials regarding our proposed recommendations. They agreed that eventually wine and distilled spirits tax bases will need to be converted to metric, but they believed there is no immediate need to revise the Internal Revenue Code. They pointed out that although wines and distilled spirits are sold in metric size containers and tax collections are based on gallons, the Department has not experienced any additional difficulties in collecting tax revenues. Furthermore, they believed that although the wine and distilled spirits industries may be experiencing some inconveniences in converting between the two systems, their problems are probably not too difficult to handle.

Department officials generally agreed that the statistical reporting requirements should be converted to metric when appropriate. They believed that converting reports to metric is feasible over time.

Recordkeeping by the industry and the Government is related to the tax rate imposed through the Internal Revenue

Code. As long as differences exist, there will be need to convert between the two systems. We believe the Department should, after considering its needs and the problems of the wine and distilled spirits industries, request that the Congress amend the Internal Revenue Code to tax wines and distilled spirits on the basis of metric quantities when such change would be to the advantage of those involved.

The officials agreed with our recommendation about the need to expand the Department's public awareness programs concerning the size and price changes that have occurred. The Department plans to look into ways to expand its public awareness activities.

Department officials, however, were concerned about the impact of our recommendation that a reevaluation be made of the 200-milliliter and 1.75-liter sizes used for distilled spirits. They believed it would be difficult to change the regulations concerning the metric sizes used and the industry would oppose further changes. They believed also that an expanded public awareness program would help alleviate the problems consumers may have.

One of the objectives sought by converting to metric sizes was to provide consumers with sizes which would allow easier value comparisons to be made. However, the 200-milliliter and 1.75-liter sizes do not permit this ease of value comparison. In fact, these sizes make value comparisons more difficult than some of the customary sizes that were in use before the conversion. While an expanded public awareness program may alert consumers to existing problems and attempt to aid them in making value comparisons, the present difficulties will continue because the sizes are not all in multiples of one another or in size series which provide for ease of comparisons.

CHAPTER 27

GENERAL PUBLIC AND CONSUMER PRODUCTS WILL BE AFFECTED

CHAPTER 27

GENERAL PUBLIC AND CONSUMER PRODUCTS WILL BE AFFECTED

Consumer reaction to metrication is a major force in determining whether conversion can be successful. Recent experiences in Australia, Canada, and the United Kingdom have shown that if conversion of some consumer products is not handled properly, adverse consumer reaction will result. Yet, these countries have reported that when consumers view metrication as not being harmful to their interests, conversion becomes a "non-event."

Many consumers in the United States are probably unaware of the changes already made. As conversions are made, consumers must be kept fully informed of what is taking place, why the changes are being made, who benefits, who pays, and how it will affect them.

Metrication would have an impact on consumers in many and varied ways. It is a trade-off of possible benefits and improvements versus the risk of no benefits and inconveniences and costs.

Consumer benefits are not automatic. Changing to metric does not necessarily reduce the number of package sizes or make the sizes used more understandable to consumers. Without proper planning, consumer benefits may not be obtained. In fact, it is possible that some of the benefits consumers have obtained over the years, such as the availability of certain products in easily understandable package sizes that facilitate price comparisons between sizes, could be lost in the conversion process.

Conversion to the metric system would involve a lot more than learning new words to describe measurements. It would involve changing the sizes of many of the items we use in our everyday lives, such as converting soft drinks from quarts to liters--an increase of about 6 percent. Many metric product sizes may not be too different from those consumers are now accustomed to, but consumers would need to learn how much each new measure is, how to relate the new sizes to the ones they now use, and how to determine which product sizes represent the good value.

Conversion to the metric system would have an impact on many activities in the day-to-day lives of consumers. Listed below are some of the changes that could occur if the metric system became the predominant measurement system.

--Milk and other beverages now sold in pints, quarts, 1/2 gallons, and gallons could be sold in 500-milliliter, liter, 2-liter, and 4-liter quantities, amounts which are about 6 percent larger than those currently in use.

--Clothing labels that now show sizes in inches and numerical size codes might show critical body measurements in centimeters.

--Meats and other products now sold by the ounce and pound would be sold by the gram and kilogram. There are about 28 grams in an ounce and 1,000 grams in a kilogram.

--Travel distances would be measured by kilometers rather than miles, and driving speeds would be measured in kilometers per hour rather than miles per hour. There are about 1.6 kilometers in a mile.

--Fuel economy might be described in liters per 100 kilometers rather than miles per gallon.

--Sporting events now measured by the foot and yard would be measured by the meter. A meter is about 10 percent longer than a yard.

--Carpets now sold by the square yard would be sold by the square meter. Consumers would need to learn that a square meter is about 20 percent larger than a square yard.

--Thermometers and thermostats would show temperatures in degrees Celsius instead of Fahrenheit. People would need to learn that a day with a 20-degree temperature is very pleasant and that water freezes at 0 degrees Celsius.

--Persons on diets would count their food intake in joules instead of calories. Each calorie is about 4.2 joules.

--Certain tools, such as wrenches and measuring devices, would need to show metric quantities. But customary tools would be needed on old items until they wear out.

--Cooks would prepare food using recipes with metric terms. New measuring devices would be needed. The cup would become a 250-milliliter measure.

--Fabric would be sold in meter lengths instead of by the yard, and the widths would be described in centimeters instead of inches.

In carrying out our study, we discussed metrication with officials at grocery products, clothing, and container industry associations; retail stores; grocery products, clothing, and container manufacturing companies; and government agencies. We also discussed the impact of metrication with representatives involved with sports. We had a public opinion polling service conduct a poll, and we sent questionnaires to large companies in the food industry. Pertinent documents were also reviewed.

CONSUMER VIEWS--LITTLE UNDERSTANDING OF THE METRIC SYSTEM

We had the Opinion Research Corporation, a public opinion polling service, conduct a survey of a representative sample of the adult population living in the United States to determine consumer views on the metric system. Opinion Research interviewed 2,109 men and women, 18 years of age and over, living in private households in the continental United States.

The persons interviewed represented 42 percent of the persons Opinion Research attempted to contact. Opinion Research compensated for not being able to contact everyone by using weighting techniques which it believed permits using the survey as representative of the entire U.S. adult population. Interviews for the survey were conducted between July 9, and August 8, 1977.

The survey showed that

--fewer than one person in five was aware of our national policy,

--more persons believed the Federal Government was doing more to increase the use of the metric system than any other group,

--few persons had sufficient understanding of common metric terms, and

--over half the persons were opposed to metric conversion and almost half believed they would not benefit if the United States converts.

Few persons were aware of actions taken by the Federal Government

Few persons were aware that the Federal Government had passed a law encouraging a voluntary conversion to the metric system. Opinion Research asked what each person thought the Federal Government had done about the metric system. The overall responses were as follows.

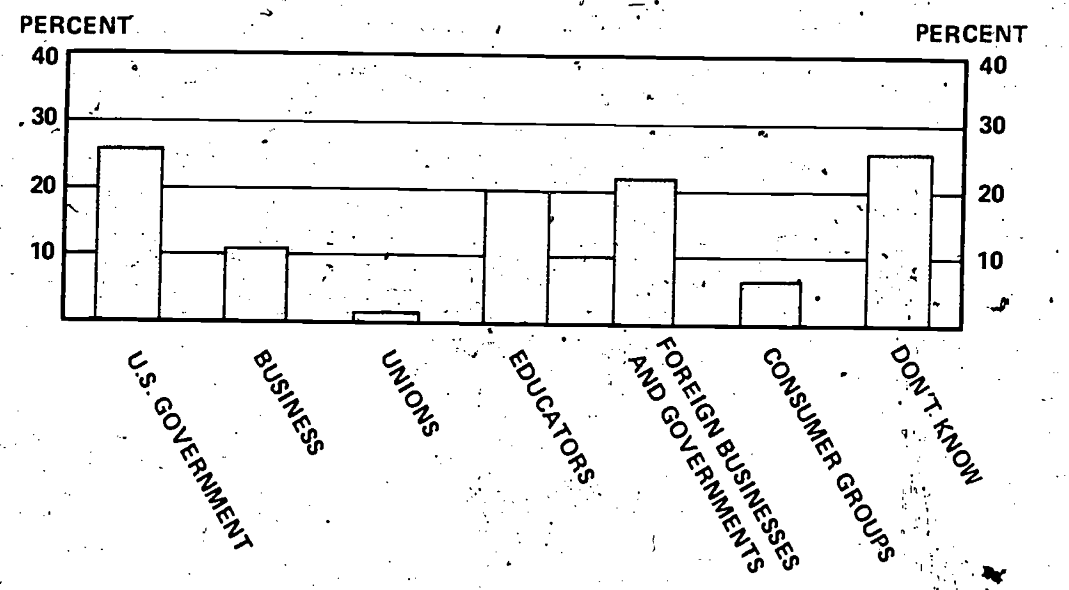
Response	Percent
Passed a law requiring the United States to convert to the metric system in the near future	23
Passed a law encouraging voluntary conversion to the metric system in the near future	18
Passed a law prohibiting U.S. conversion to the metric system	2
Hasn't passed any law one way or another about the metric system	27
Don't know	30
Total	100

Further analysis of the overall responses showed that awareness that the current Federal position is to encourage conversion on a voluntary basis was highest (32 percent) among male adults between ages 18 and 29. Among respondents who had an executive, professional, or managerial occupation, 32 percent believed that a law had been passed requiring the United States to convert to the metric system. This indicates that persons in the more influential job positions might take actions to move the Nation toward conversion simply because they believe it is required. Awareness of what the Government has done was lower among persons who are older, have lower incomes, live in the South, or are nonwhite.

Views differ on who is encouraging increased use of the metric system

As shown in the diagram below, more persons (26 percent) believed that the Federal Government was doing more to increase metrication in the United States than business, unions, educators, foreign businesses and governments, and consumer groups. The announcement by the Federal Highway Administration before the survey that it planned to have highway speed

signs converted to metric by the end of 1978 and the subsequent withdrawal of that proposal (see ch. 10) may have contributed to this response.



Few persons were familiar with metric terms

Few persons had sufficient understanding of the terms meter, liter, gram, and degree Celsius--terms that would be in common use in a metric society--to identify their approximate values. Opinion Research asked each person the following questions to determine the amount of public understanding of common metric terms.

--If you purchased a liter of milk, would you receive about a glassful, pint, quart, half gallon, gallon, or don't you know?

--If the temperature outside is 20 degrees Celsius, would the weather be cold, requiring you to wear a heavy coat; be chilly requiring you to wear a light jacket; be comfortable, so that you would not have to wear any outer garment; be hot, good for swimming; or don't you know?

--If you purchased 500 grams of luncheon meat, would you receive about 1/4 pound, 1/2 pound, 3/4 pound, 1 pound, 2 pounds, or don't you know?

--If you purchased a meter of cloth, would you receive about 1 inch, 6 inches, 1 foot, 1 yard, or don't you know?

The correct responses to these questions were

--a liter of milk is about a quart,

--a temperature of 20 degrees Celsius would be comfortable so that a person would not have to wear any outer garment,

--500 grams of luncheon meat is about 1 pound, and

--a meter of cloth is about 1 yard.

The number of correct responses to the above questions was as follows.

Number questions answered correctly	Percent of responses
All four	4
Three	12
Two	15
One	19
None	50
Total	100

More persons responded that they did not know the answer than any of the other responses. However, among the persons who gave answers, overall more gave the correct answers than incorrect answers, as follows.

Measurement term asked about	Percent response given		
	Don't know	Correct answer	Incorrect answer
Liter	47	32	21
Degree Celsius	49	24	27
Gram	67	12	21
Meter	54	37	9

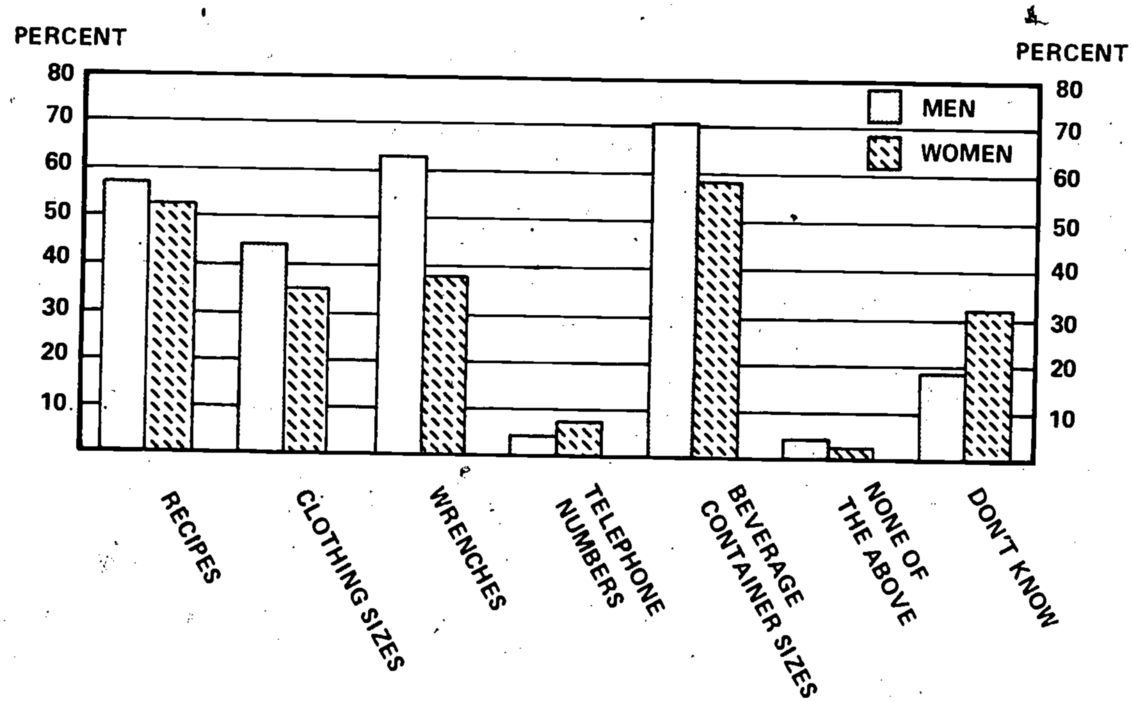
Opinion Research's survey showed that men between the ages of 18 and 29; college graduates; heads of households who were in an executive, managerial, or professional occupation; persons whose annual income was $25,000 or more; and persons who had lived in a foreign country that used the metric system had a better knowledge of the common terms than other people did. Among women, those who were employed had a higher metric awareness than housewives.

Lowest awareness of the common metric terms occurred among persons who lived in the South, were older, and were nonwhite.

Views on common items that would change if metric conversion occurs

Awareness of several items that would or would not change was higher than for the understanding of specific measurement terms. We asked each person if the following common items--recipes, clothing sizes, wrenches, telephone numbers, and beverage container sizes--would be changed if the United States converts to the metric system.

Over one-fourth of the persons did not know whether any items would change, but among the 74 percent that responded, most were aware of what would happen to these items. Awareness was higher by men than women as shown in the following diagram.



It may be that awareness of changes in beverage container sizes was higher because of the conversions that have been made in the soft drink, wine, and distilled spirits industries (see ch. 26). Low awareness of changes to possible clothing sizes may be due to the fact that few clothes show metric measurements on the labels and many clothing labels, particularly those for women's and children's clothing, show numerical size codes rather than measurements.

A majority opposed converting to the metric system

Fifty-eight percent of the persons interviewed were opposed to the United States converting to the metric system; 43 percent described themselves as being strongly opposed to converting. Twenty-eight percent said they favored conversion, and 14 percent did not voice an opinion.

Support and opposition on converting varied by age groups. Support diminished and opposition increased in older age groups as shown below.

Views on converting to the metric system	Ages 18 to 29	30 to 44	45 to 59	60 and above	Overall
	(percent)				
Support	41	31	20	14	28
Oppose	46	58	66	64	58
No opinion	13	11	14	22	14
Total	100	100	100	100	100

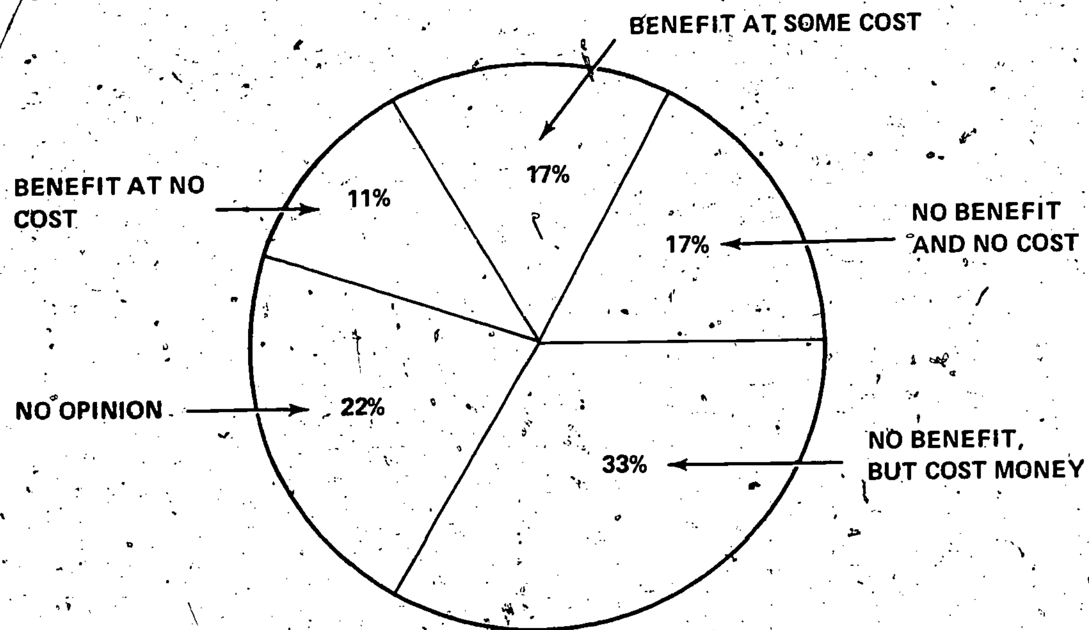
But, while support diminishes in older age groups, it increases with the education level. Support was highest among college graduates--55 percent favored converting. But among persons with a high school education or less, 65 percent were opposed to converting.

Views on converting to the metric system	Educational level			
	Less than high school	High school graduate	Some college	College graduate
	(percent)			
Support	10	26	46	55
Oppose	67	63	45	38
No opinion	23	11	9	7
Total	100	100	100	100

Views on metric conversion varied by the occupation of the head of the household. Persons in jobs with higher skill requirements favored conversion to a much greater extent than those with lower skill jobs or who were retired.

Views on converting to the metric system	Occupation of head of household				
			Blue collar		
	Executive, professional, or managerial	White collar	Skilled	Semi-unskilled	Retired
	(percent)				
Support	46	38	27	17	15
Oppose	47	52	63	64	64
No opinion	7	10	10	19	21
Total	100	100	100	100	100

Almost half the persons interviewed believed they would not benefit by the United States converting to the metric system. Also, half the persons believed that converting would cost them money. Persons' views on whether they would benefit or not were as follows.



Other polls show public opposition to converting to the metric system

Other polling organizatons have also conducted polls on the public's views toward the metric system. These polls have generally found that more people oppose than support converting to the metric system.

For example, in November 1977 the Gallup Organization, Inc., reported that public awareness of the metric system had increased during recent years but that support for converting had decreased during 1977. Gallup reported in November 1977 that 74 percent of the public was aware of the metric system's existence. In 1965, when Gallup first asked the public about the metric system, only 29 percent were aware of it. By 1971 the amount had grown to 44 percent; by 1973, 54 percent; and by January 1977, 74 percent.

In 1973 Gallup found that 16 percent of the public supported conversion, and in January 1977 it found that 29 percent of the public supported conversion. However, in November 1977 Gallup reported that this support had dropped to 24 percent.

GROCERY PRODUCTS--FEW CONVERSIONS, BUT SOME PLANS

About 80 percent of the labels on prepackaged grocery products show metric equivalents; that is, they show both the customary quantities, such as 1 pound, and the metric quantity, such as 454 grams. One producer told us the practice began over 10 years ago because the labels for exported items were changed to show metric quantities. The practice has increased during recent years so that it is now a common practice to show metric equivalents even though the product is not exported. We did not identify any consumer reaction to the inclusion of metric equivalents on grocery product packages.

Very few products other than beverages (see ch. 26) have been converted into round metric quantities, such as 1 liter or 1 kilogram. The grocery products industry saw few benefits in changing container sizes. It has been reluctant to make changes because of labeling requirements in the Fair Packaging and Labeling Act, and the industry feared there would be adverse consumer reaction.

There appears to be no incentive for the grocery products industry to convert its products to metric sizes. Several major producers in the industry, however, have looked into it because they view metrication as inevitable. Also, several industry trade associations have conducted studies on metrication.

Some consumer advocates view conversion of food and other products sold in grocery stores as providing an opportunity for establishing sizes that will make price comparisons easier. Some believe that metric terms will be more easily understandable to consumers because they are based on a decimal system.

Whether the objectives sought by consumer advocates can be achieved will depend on (1) producers' ability to change the container sizes, (2) their willingness to abandon traditional sizes and marketing techniques, (3) their costs, (4) government requirements, and (5) pressure received from Government agencies and consumers to make changes.

Packaging affects conversion flexibility

Converting to rational package sizes appears unattainable for many products because some containers used for grocery products cannot be easily changed. For example, cans are used for many products. Some standard can sizes are used for more than one product. The weights of the contents vary

because of the different densities of items placed in the cans.

At our request, the Can Manufacturers Institute, a trade association of 56 metal can manufacturing companies that make 90 percent of the domestic cans, surveyed its membership about their views on converting to the metric system. Twenty companies responded.

Although the number responding was not significant enough to provide a basis on which to estimate the views of the entire can manufacturing industry, we believe the responses provide an indication of how metric conversion would affect the industry. We had no basis on which to judge the extent to which the views of those who responded differed from other producers in the industry.

Nine companies believed that changing to the metric system was desirable, eight thought converting was not desirable, and three said that it might be desirable. Companies cited the following advantages:

--Standardization within the industry.

--Ease in arithmetic determinations.

--If fewer sizes are required, there potentially may be a lower per item cost to the consumer due to longer production runs and fewer inventory items.

--Greatest advantage noted would be to facilitate participation in world markets.

--Easier product comparison by the consumer.

The companies cited the following disadvantages:

--Overwhelming cost with no corresponding increase in profit.

--The writeoff of usable supplies and tooling.

--Retraining cost and employee/customer acceptance.

Eighteen companies believed that conversion was inevitable. One said that conversion was not inevitable, and one said that conversion may be inevitable.

Most companies (13) favored voluntary conversion to the metric system as currently provided in the Metric Conversion Act of 1975. But five favored a mandatory conversion, one

thought it totally unnecessary to convert, and one was undecided on whether conversion should be mandatory or voluntary.

The companies anticipated that products historically sold in round customary units would be converted to round metric quantities. For example, cans of coffee have historically been sold by the pound. These cans would be hard converted to 500 grams--an increase of about 10 percent.

Companies anticipated that can sizes will not be changed for products, such as most fruits, vegetables, and liquid drinks, which have historically been sold by the can. For example, cans of corn (normally 16-1/2 ounces), peaches (approximately 18 ounces), or large fruit drinks (46 ounces) would not be changed. The companies believed that because the products are not sold in round customary units, there is no justification for attempting to convert them to round metric units. Further, because product densities frequently vary from packer to packer or from one vegetable to another, there would be no way to develop container sizes that would hold a round metric product amount without vastly increasing the number of metal container package sizes.

Companies believed that changes in can heights would be easier to make than in the diameters because costs would be lower. In making metric conversions in Canada, food producers did not anticipate changing can sizes when the costs would be too high.

Many glass jars are specifically developed for individual products. New glass molds are required from time to time. If required to convert, metric glass molds could be built as customary molds wear out to minimize waste. However, coordination among producers needing glass molds would be necessary to prevent strains on the glass industry's mold making capacity.

In Canada we were told that conversions of dry cereal products were limited because the cereal industry found it would be much less costly to convert if it did not have to change the sizes of the boxes. Conversion was accomplished by changing the amount of cereal placed in the boxes to metric quantities in 25-gram increments. But, it was not always possible to develop package size series that consumers could easily use to make price comparisons. We were told by the Cereal Institute that no cereals sold in the United States have been converted to round metric quantities.

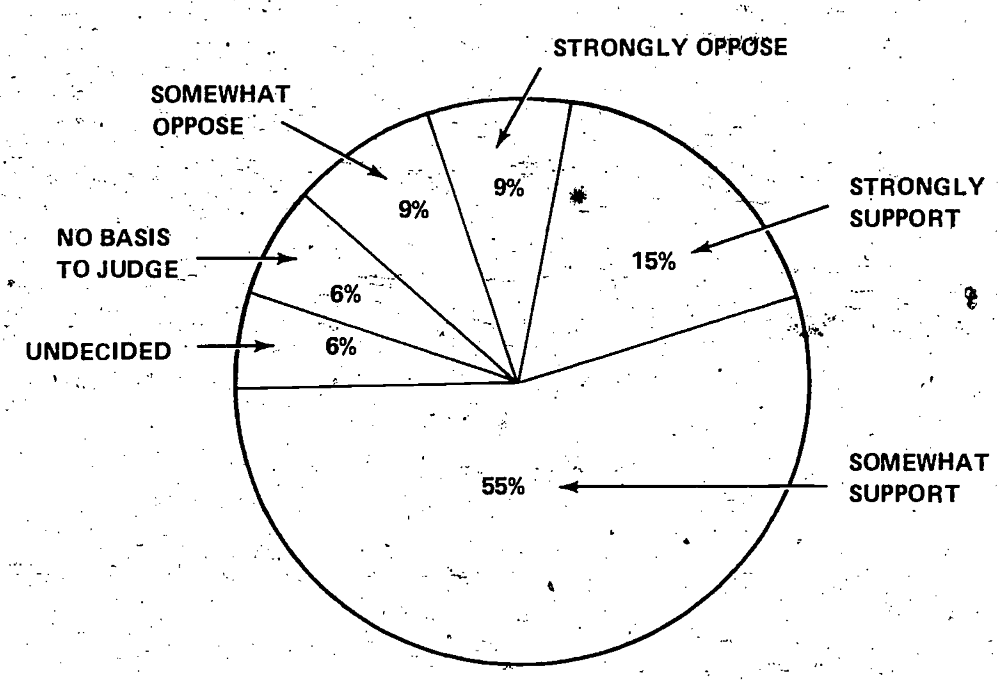
Major food producers' views on metrication

Of the large corporations we sent questionnaires to (see ch. 5), 69 were listed as being in the food industry. We received usable responses from 47 of them.

Most of them appeared to understand the current national policy, believed metric conversion is inevitable, and supported metric conversion even though they believed that for their industry the disadvantages outweighed the advantages. They had made few plans to convert. Food corporations appeared not very measurement sensitive, and most said they could convert in a reasonable time frame.

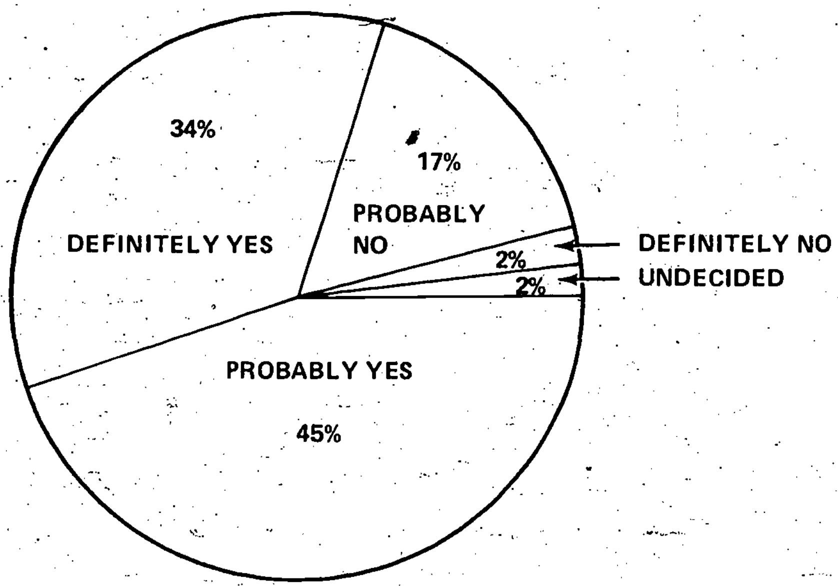
Sixty-six percent of the corporations were aware that the current national policy is for Federal coordination and planning voluntary conversion to the metric system. But, 13 percent believed that conversion was mandatory. The others believed there was no national policy and no provision for converting or replied that they did not know what the national policy is.

Although most corporations in the food industry supported conversion to the metric system, support was not strong.



Most believed conversion was inevitable

Almost 80 percent of the corporations also believed it was inevitable that the food industry would convert to the metric system. Their responses to the question, "Does your company believe that conversion to the metric system is inevitable for your industry?" were as follows.



We subsequently asked the corporations that believed conversion was inevitable why they believed this was true. Among the reasons given were:

--Growing participation in world markets makes it important to use a common measurement language.

--The metric system is easier to use, and support will grow for its use because of the benefits of simplicity, accuracy, and standardization.

--Technology in the food industry--use of computerized checkout counters and inventory controls, unit pricing, and nutritional labeling--is facilitated by use of units expressed metrically.

--The dual labeling (showing of both customary quantities and their metric equivalents), which has occurred in the food industry, is a recognition of the inevitability of converting.

--Society cannot successfully use two measurement systems. It is logical for the United States to use the metric system because the world will not adopt ours.

--The Government has provided for establishment of a U.S. Metric Board. Events in Canada indicate that once a Board is established, conversion timetables will be established.

Metrication would not increase exports

Metrication was not expected to increase the exports of 98 percent of the companies. They considered having competitive prices, high quality products, and a good reputation and reliability the most important factors in promoting their exports. But 9 percent of the corporations believed that imports to the United States by their overseas competitors would increase slightly if the United States converted to metric.

The measurement system used was not considered a significant factor in influencing industry exports. Whether products are in customary or metric measure seemed to have little bearing on industry views toward exports.

Disadvantages outweigh advantages

Most were of the opinion that individually the disadvantages of converting to the metric system outweighed the advantages. Yet, they believed that for the United States overall, advantages would outweigh the disadvantages. Their responses on the advantages of converting to the metric system versus the disadvantages were as follows.

Perceived impact	Percent	
	For the corporation	For the U.S.
Advantages significantly outweigh disadvantages	6	26
Advantages slightly outweigh disadvantages	15	34
Advantages about equal disadvantages	19	11
Disadvantages slightly outweigh advantages	28	8
Disadvantages significantly outweigh advantages	26	8
No basis to judge	6	13
Total	100	100

Sixty-two percent of the corporations believed converting to metric would have little or no impact on their product prices. Twenty-eight percent expected some increases in product prices. Only 2 percent (1 respondent) believed that major price increases would occur. Four percent (two respondents) said they had no basis to judge the impact on prices.

Most respondents believed the principal role of the Federal Government should be to coordinate conversion activities and counsel and advise interested parties.

Fifty-two percent of the companies believed it would take between 5 and 10 years for them to convert to the metric system. Most companies believed that if the United States converts to the metric system, the conversion dates should be established by industry associations and individual firms.

Food recipes

Metrication will mean developing new food recipes. People who cook will have to learn new terms. It is not expected that food ingredients will need to be weighed when cooking with metric recipes.

Some new measuring utensils will be needed at a cost of several dollars in order to use metric recipes; however, there would be no need to purchase new pots, pans, appliances,

cookie sheets, and many other items. If conversion occurs, all items will eventually show metric quantities.

Continued use of old measuring devices and recipes is expected to be encouraged. Because recipes cannot be easily soft converted, it is expected that many persons will continue to use customary recipes for many years. Experts say that before recipes can be converted, they need to be retested because the soft conversions of some customary quantities do not appear on metric measuring devices. Metric recipes will contain slight variations of existing contents.

It can be expected that a certain amount of confusion may occur if metric recipes are introduced. To use these recipes, cooks would need to learn to measure liquid and dry ingredients by the milliliter instead of by the cup or fractions of a cup. They would also need to understand Celsius temperatures and how to convert temperatures if their ovens are not metric.

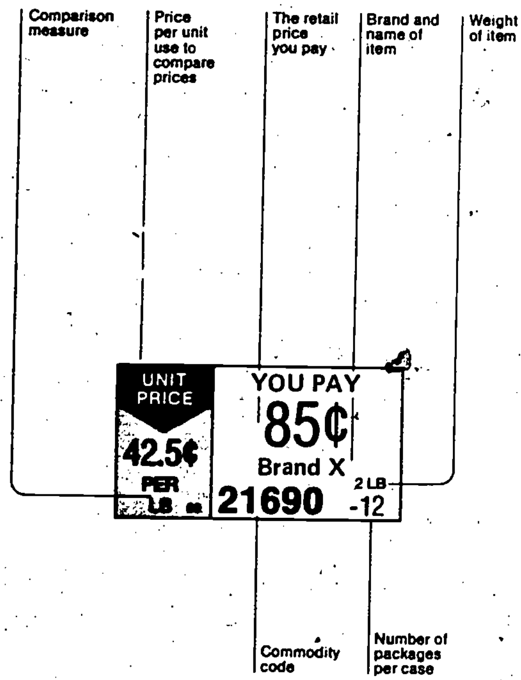
Coordination between food producers and recipe developers would be needed. Some food products, such as packages of yeast and chocolate squares, are made in quantities usable in recipes. Some recipes require use of commonly used quantities of products, such as a stick of butter (1/4 pound). Persons would need to learn to make adjustments if significant changes are made to package quantities they are familiar with.

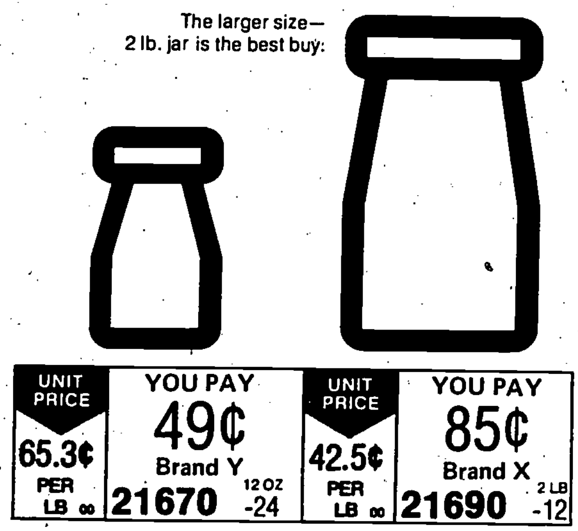
Converting to metric recipes would not make food taste better. However, some home economists claim that metric recipes would be easier for cooks to use because fractions are eliminated.

Unit pricing would still be needed

Unit pricing, a consumer service first offered in supermarkets over 5 years ago, is a method of pricing products that lets consumers compare product prices in common units, such as pounds, ounces, quarts, or pints. A glance at a unit price display usually located directly under each food product display, can show a consumer which size is the more economical buy, regardless of the variety of sizes on the shelves.

Unit pricing enables consumers to compare prices without having to make complicated mathematical calculations. Studies have shown that if presented effectively, unit pricing can significantly reduce price comparison errors by consumers. The unit pricing labels shown on the following page, provide an example of the comparisons consumers can make.





Compare on Value
To compare costs of a product in different sizes or brands, just look at the price on the unit price side of the label . . . then compare that unit price against another, checking price per measure, brand to brand, size to size.

Nine States have unit pricing regulations. Some cities, such as Chicago, also require unit pricing. There are no Federal laws or regulations concerning unit pricing.

Where unit pricing is used, consumers can compare

--price per pound for items, such as rice, which are sold by weight;

--price per quart for items, such as juice, which are sold by liquid measure;

--price per 100 count for items, such as napkins, which are sold by number; and

--price per 100 square feet for items, such as aluminum foil, which are sold by length.

Metric conversion will not end the need for unit pricing in supermarkets. Even if metric size series are selected that make price comparisons easy for consumers, not all products will be converted to these sizes. There will still be products, such as those sold in cans, which may not be easily converted into quantities different or more understandable than those currently in use.

Conversion to metric would require the establishment of new units of comparison. In Canada, for example, items sold in units of volume now use 100 milliliters as the metric unit of comparison. For items sold by weight, the unit of comparison is 100 grams. Some bulk sale items, such as sugar, flour, and dry pet foods, are unit priced by the kilogram. Unit pricing was also revised to use the square meter as the unit of comparison for items such as aluminum foil, the meter for paper towels, and the liter for powdered laundry detergents and large packages of ice cream.

Care would need to be taken to ensure that stores do not intermingle customary and metric units of comparison. In Canada certain supermarkets converted the unit price labels for individual products at the time the products themselves were converted. This resulted in some products in a store having unit price labels in customary units, while other products had their unit price labels in metric units. When this happened, consumers were not only faced with new and different package sizes and measurement terms on package labels, but could not use unit pricing to determine which products were of better value.

<u>Conversion could be used to improve package sizes</u>

Under the Fair Packaging and Labeling Act (80 Stat. 1296, 15 U.S.C. 1451), the National Bureau of Standards has established 50 voluntary package quantity standards 1/ for foods and other consumer products. These standards may have helped to reduce the number of product sizes in the marketplace. However, more improvement is needed. Metric conversion could be used as an opportunity to make desirable changes.

Under the act, NBS is to determine whether the reasonable ability of consumers to make value comparisons of packaged consumer commodities is impaired by the undue proliferation of the weights, measures, or quantities in which the commodities are offered for sale at the retail level.

NBS is responsible for eliminating undue proliferation of package sizes. To accomplish this, voluntary product and package quantity standards have been developed. The Secretary of Commerce may recommend to the Congress that regulatory authority be legislated when industry members do not participate

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1/Standards are criteria established by Government or industry bodies to provide rules or measures of quantity, quality, weight, extent, or value on products or services.

in developing voluntary product standards or they do not adhere to the voluntary standards that have been developed.

NBS is also to promote nationwide uniformity in the labeling of consumer products to facilitate the exercise of good judgment by consumers in the marketplace. It has requirements that producers must follow when labeling their products.

A large number of sizes are still permitted for many products which do not always provide consumers ease of price comparisons. Also, producers do not always comply with the voluntary size recommended. NBS has never recommended that the Congress legislate sizes for products that do not adhere to the sizes that have been established.

Metrication could be used as an opportunity to further improve the current package sizes by converting products into logical size series that would make price comparisons easy between sizes and between various manufacturers' products. Whether improvements would be realized is largely dependent on industry willingness and ability to adjust package sizes. Cooperation would be needed between the industries involved and the Federal and State government agencies that regulate package sizes.

For example, NBS would need to amend the voluntary size standards that are used for items such as toothpaste, frozen vegetables, soft drinks, and soaps. But States would need to amend the size requirements for items such as milk and beer.

Metrication, however, is not essential to achieve rational package sizing. Rational package sizes can be established using customary quantities. Products, such as flour, bread, and butter, are sold in many States in rational sizes established by State laws and regulations.

If package sizes are converted to metric sizes where rational sizes are not now in use, the changes should be used to benefit consumers and the industries involved. For example, NBS has established a voluntary size standard for toothpaste. Under the standard, producers should be using five customary sizes--1.5, 3, 5, 7, and 9 ounces. According to NBS, toothpaste was sold in 57 sizes before the size standard was established in April 1971.

A limited 1973 NBS survey showed that 13 sizes were being sold. At one supermarket in the Washington, D.C., area we observed in August 1977 that toothpaste was being sold in 10 sizes. Only three of the standard sizes were among them. At another supermarket we observed in November 1977 that toothpaste was being sold in the 5 standard sizes plus 13 others--

2.1, 2.6, 2.7, 2.8, 4.0, 4.25, 4.3, 4.5, 4.6, 6.0, 6.4, 6.5, and 8.2 ounces. In the absence of unit pricing, it could still be difficult for consumers to make price comparisons between many of the sizes available for sale.

The 5 standard toothpaste sizes established by NBS, if used, would represent an improvement over the 57 sizes that were used before. But the standard sizes established by NBS do not make price comparisons as easy as if the sizes were in multiples of one another or in a numbering series which can easily be compared with one another. Furthermore, in view of the large number of sizes still in use and the odd weights in which toothpaste is being sold, industry compliance with the standard cannot be considered a total success.

NBS has not been totally successful in establishing package sizes for toothpaste and obtaining industry compliance with the voluntary size standard. Would it be any more successful with metric sizes?

The Fair Packaging and Labeling Act requires that product labels show content weights in customary measurements. Use of metric terms, while widespread, is optional, provided that customary terms are also shown.

If a conversion of grocery products is to be made, the Fair Packaging and Labeling Act will need to be amended to provide for labeling in metric quantities, and new size standards will need to be developed.

CLOTHING AND PATTERNS--HOPES FOR BENEFITS

The clothing industry is in the early stages of converting its products to metric. We did not identify any clothing being manufactured in metric sizes, but:

--At least three clothing producers have begun to show metric equivalents on some clothing labels.

--A trade association of clothing manufacturers made an extensive study of the impact of metrication. It concluded that metrication offers the industry a once in a lifetime opportunity to develop more uniform and rational garment sizes, size intervals, and size numbering systems shown on clothing labels. It also concluded that Government aid would be needed to study human body measurements so that new clothing size standards can be developed.

--A trade association of retailers that sells clothing through the mails also favors converting clothing

sizes to metric and has begun work within the industry to prepare for a changeover.

--The clothing pattern industry has been showing metric equivalents on the patterns used in home sewing since 1971. The practice began because of the metric conversion being made in the United Kingdom. Patterns designed in the United States are also sold in Australia, Canada, several European countries, South Africa, and New Zealand. The patterns sold in the United States show instructions in several languages and in both customary and metric measurements.

No changes have yet been made to the sizes used for clothing or patterns. The clothing that has metric labels and the patterns that show metric measurements are still designed and manufactured in customary measurements. The metric measurements are all conversions to the nearest metric equivalents.

Voluntary clothing size standards for women's and children's clothing were developed by NBS in cooperation with the clothing industry. No Government clothing standards have been developed for men's clothing.

The standards for women's and children's clothing are based largely on body measurement studies that were made during the late 1930s. The data is believed to be out-of-date and not useful for continued use in clothing size standards.

We were told that body shapes are continually changing. Persons are taller and slimmer than they were during the 1930s when the last comprehensive study was made. Today's emphasis on appearing youthful and maintaining a trim look have an impact on the size and shape of body measurements and therefore on clothing size needs.

The studies made during the 1930s included data only on white children and female adults. The clothing industry believed it needs data representative of all persons in the population to develop clothing standards that would meet the Nation's needs.

The clothing industry believes that a new body measurement study should be made regardless of whether it metricates because the existing size standards need to be updated. However, several major clothing producers have concluded that it will not be possible to convert to metric clothing sizes without a new body measurement study because sufficient information on body measurements is not currently available. In a test made to try to convert to metric sizes, several clothing

producers found it impossible to make clothing in metric size intervals using existing data and clothing sizing techniques.

The clothing and pattern industries believe that the Government should conduct a new body measurement study. The clothing industry is comprised of many firms. It believed there would be no reasonable way to get the full cooperation of the industry to assist in paying for a study. Furthermore, several major clothing producers believed that the results of a study would also be useful to others, such as the furniture and automobile industries, that have need for information on body measurements.

In December 1977 NBS issued a report on a pilot study it made on the need for data on body measurements and other factors affecting products and equipment used by consumers and workers. The study recommended that a survey be made to determine (1) the needs and priorities for such data and (2) an assessment of the alternative technologies available for obtaining, storing, and processing such data. It estimated that a survey would take 2 years and would cost $1.1 million.

The clothing industry expects to benefit

The clothing industry believed that metrication would provide a unique opportunity to develop a uniform, rational range of metric garment sizes and size intervals. Over the years a proliferation of clothing sizes has occurred which industry officials believed benefits neither manufacturers, retailers, nor consumers. Size proliferation has occurred as a result of demand from consumers and retailers, actions by competitors, and the sales and marketing operations within clothing companies.

The clothing industry also believed metrication would give it the opportunity to reduce the number of sizes produced with the possibilty of reducing inventory costs. It also believed consumers would benefit if improvements were made in clothing size standards because clothing should fit better, even though the number of sizes may be reduced.

Only minor differences exist between some of the sizes now used. Industry officials believed elimination of some sizes would not occur unless a major change was made in the industry, such as metrication.

Some industry officials also saw converting to metric as an opportunity to change the size coding systems used on labels for women's and children's clothes. They believed that showing key body measurements, such as the waist or hip, which the garment is designed to fit, would benefit consumers.

Because of the present coding system, women do not fit into the same size garments in all stores; many retailers do not use the same garment size codings to fit the same size bodies. Industry officials told us this would not occur if garments showed the key body measurements the clothes were designed to fit.

We were told the industry is reluctant to eliminate the size coding systems used for women's and children's clothing. Many retailers, for example, are concerned that consumers will react unfavorably to changes in the coding systems they are familiar with, particularly because metric measurements are in larger numbers than those currently used.

Industry officials believe the changes they would like to see could not be achieved without metrication. For example, they believed that metrication would force industry members to get together and examine the sizes now used for clothing. They believed that without metrication, the industry probably would not get together on its own.

Several major producers in the industry are hopeful that metrication would provide the industry with the opportunity to correct problems which have developed over the years and provide for permanent benefits. Whether this will happen appears to be speculative at this time. Use of clothing size standards is voluntary, and there is no assurance they would be used throughout the industry. It is expected, however, that if major clothing retailers convert to metric sizes, most others in the industry will adopt metric sizes voluntarily.

Costs of converting

According to a study made by the American Apparel Manufacturers Association, a trade association of clothing manufacturers, conversion costs are expected to be minimal for apparel manufacturers. Metrication could involve modifying some equipment into metric calibrations, maintaining dual inventories of machine parts, modifying measuring devices and testing equipment, educating and retraining employees, and providing metric tools.

The Apparel Association believed that retailers would be concerned with soft changes, such as vocabulary, labels, and promotional bulletins and signs. Physical changes, such as redesigning or changing equipment, need not take place until new equipment is purchased.

An NBS official estimated that a body measurement study would cost between $5 million and $7 million.

Impact on international trade is not known

An official of a large retail company told us that the clothing his company imports is made overseas to the customary size standards used in the United States.

Some clothing industry members believe metrication would provide opportunities for domestic manufacturers to increase exports. Others, however, believe it would further facilitate imports of foreign garments, particularly if sizes used in other countries are chosen.

TEMPERATURES--A DIFFERENT DEGREE

Consumers use temperatures for determining weather conditions, cooking, and setting household temperatures and freezers. Temperatures are also used in health care. To convert from Fahrenheit to Celsius, subtract 32 degrees from the Fahrenheit temperature, then take 5/9 of the remainder. However, if metrication occurs, few persons would need to know how to make this conversion because they presumably will learn to relate the Celsius temperatures to the circumstances involved.

The Fahrenheit scale is commonly used in the United States today. The metric system has its own scale called Celsius. Some persons may already be acquainted with it, but their exposure may have been when it was known as Centigrade.

People know cold and hot by their senses, but they determine the exactness by referring to temperatures. For example, 20 degrees Celsius is a comfortable room temperature; 37 degrees Celsius is the normal body temperature. If the freezer is set at 5 degrees Celsius, ice cream will melt.

Many weather forecasters now refer to degrees Celsius in daily weather forecasts (see ch. 28). It is unlikely that many consumers are aware of what the various temperatures mean. Some hospitals use Celsius thermometers when caring for patients.

It is unpredictable how many persons would buy new thermometers to replace the ones they have. When cooking, persons may use conversion tables to determine proper cooking temperatures instead of buying new stoves that show Celsius temperatures. Persons will probably not buy new thermostats for their homes; persons in older homes would have to remember what a comfortable room temperature is in terms of degrees Fahrenheit. Use of the Fahrenheit temperature scale will continue to some extent for many years.

SPORTS--AN ASSORTMENT OF METRIC AND CUSTOMARY

Because of their high visibility, sports are considered an excellent vehicle for teaching the public to think metric and draw attention to the metrication of a country. For instance, Canada is following this approach in its conversion activities by trying to convert its highly visible sports, such as football, horse racing, and golf. Canadian plans call for the metrication of sports by January 1979; some sports, primarily international sports, have already converted. Australia has successfully implemented this approach.

Our discussions with representatives of selected sports in the United States indicated that metrication is taking place in track and field events and to a lesser extent in swimming, primarily because of international competitions. International records in both sports are recorded primarily in metric terms. There is little activity in other sports with few if any plans in professional sports.

College sports

The National Collegiate Athletic Association has decreed that all rules and dimensions for all sports, except football, would be expressed in both customary and metric units of measure. However, no deadlines or time frames were established for beginning use of metric terms. The Athletic Association would provide the metric measurements for the various sports if the United States adopts the metric system. Basically, it has left it up to each sport to do what is best for the sport as far as conversion is concerned. A spokesperson said that the metric system is used in sports in other countries and it is a more logical system. Other than that, he sees no particular benefit to conversion.

Track and field has made the conversion to metrics. Some events have been changed to metric distances and other events are simply being measured in metric units. For example, in track, the 440-yard dash has been changed to the 400-meter dash, about 8 feet shorter.

Even in those events where some changes in distance have occurred some other measurements have not been changed. Some tracks have been modified to accommodate the metric distances, but the width of the track and the lanes have not been changed, nor has the distance between hurdles.

Because the distances of running events have been changed, separate records will be maintained between the customary and metric events. Separate records will not be maintained for field events, such as the shotput, where

measurement is involved because the distances in customary units can be converted to metric units.

High school

In April 1977 the National Federation of State High School Associations, which is the governing body for interscholastic athletics, stated that running events shall be changed to the accepted metric distances in 1980. Schools building or refurbishing track facilities were encouraged to make accommodations for metric races. Conversion was not made mandatory but was up to each State School Association. The Federation stated only that starting in 1980 it will no longer list races at the traditional English distances--either in the order of events, the honor roll, or soon after in the list of national records.

A spokesperson for the Federation said he does not anticipate conversions in other high school sports.

Swimming

Some conversion is being made and some metric events are being added to competitions. Spokespersons for the National Collegiate Athletic Association and the National Federation cited the high cost of converting pools as a deterrent to conversion in this sport but said, however, that new pools are built to metric dimensions.

Football

The National Football League has stated that when the United States changes to the metric system, it would have to declare itself exempt. It was the League's position that football is based on yardage and that to convert to meters would alter drastically the basic part of the game. To convert existing yardage to its metric equivalent would be extremely confusing.

It is interesting to note that at the college level, a metric football game was played in Northfield, Minnesota, between Carleton and St. Olaf Colleges. The field was relined to 100 meters long (about 109 yards) by 53 meters wide (about 58 yards) with meter lines every 10 meters.

Baseball

The Commissioner of Baseball has not taken an official position on metrication; however, a spokesperson stated that metrication would not change the sport. Existing dimensions, etc., would simply be converted to their metric equivalent

units. The spokesperson saw no advantage to converting baseball and believes any conversion at this time would only confuse people. He did note that at some ball parks the distances to the walls were being shown in metric units, but this is at the initiative of the individual clubs.

Horse racing

An official of the Thoroughbred Racing Association informed us that it has no metric policy and is not considering metrication. The Racing Association did contact the Jockey Club to see what, if anything, it planned to do and found it had no plans.

Golf

Neither the Professional Golfers Association nor the U.S. Golf Association report much metric activity. Neither has taken any metric action and both have adopted a wait-and-see attitude. A spokesperson for one of the Golf associations said he believed conversion would be confusing for both the participants and the public, at least until people become familiar with metrics. Some golf courses are now showing distances on score cards and on some course markers in both yards and meters.

Basketball

A spokesperson for the National Basketball Association said that metrication would not really affect the sport because all distances and heights would remain the same. If the country does go metric, these dimensions may be converted to their metric equivalent.

Tennis

A spokesperson for the United States Tennis Association told us that court dimensions are standard in the United States and in other countries. The dimensions are in customary units in the United States and as far as he knows in other countries also. He knows of no move to convert the courts to metric size although he believes they could easily be converted to their metric equivalents.

Soccer

The dimensions of the field are expressed in yards but are in a maximum and minimum range. A spokesperson for the U.S. Soccer Federation saw neither problems in converting the dimensions to their metric equivalent nor a move to do it. The official rules include a table showing field dimensions,

ball size, etc., in both customary and metric units. The field sizes are different for international competition and are expressed in metric units.

Skiing

Skis, both foreign and domestically produced, are dimensioned in metric units and have been for a long time. According to a spokesperson for a trade association, skis were traditionally imported and were dimensioned in metric units. When U.S. manufacturers entered the market, they used metric dimensions to be compatible with the foreign imports.

CONCLUSIONS

Consumer acceptance is one of the most crucial, if not the most crucial, areas involved in achieving a metrication program.

Few consumers had a clear understanding of the metric terms they would use in their daily lives. This is particularly true for persons who are older, have a lower income, are without much education, or are in a minority.

A majority of consumers did not favor converting to the metric system. Many saw no benefits in converting. If a conversion is to be made, adequate steps are needed to ensure that consumers benefit to the extent possible, have their interests protected, and are informed and educated about the system so they do not feel uncomfortable with it. Consumers should have a voice in the decision. Otherwise, public resistance is likely to occur which would make it difficult to convert those sectors of the economy that believe they can benefit.

If we are to convert, the Government will need to undertake public awareness programs. These should be coordinated with conversion and promotional activities that take place in the public and private sectors. Both sectors should share the burden and will need to work together.

If the United States continues to implement its present voluntary metrication policy, it can expect much confusion in the marketplace. Without a firm Government commitment, some product sizes will convert; others will not. Proliferation of package sizes may result. Consumers may not be able to understand many size designations, and it may become difficult for them to make value comparisons.

Metrication of many products cannot be done on a voluntary basis. Many States have laws and regulations which

require the use of customary sizes for products, such as bread, flour, and butter. Most States also have weights and measures laws or regulations that tend to limit use of metric measurements for retail scales (see ch. 9).

At the Federal level, the Fair Packaging and Labeling Act requirement that customary terms be used on package labels tends to discourage conversion. Producers are permitted to show both customary and metric quantities on their labels, but they cannot convert to labels that show only metric quantities. Product size standards for certain food and other items, such as detergents, prescribe customary quantities.

Under the current national policy, if the grocery products industry decides to voluntarily convert to the metric system, the Secretary of Commerce would need to develop new voluntary size standards. It is quite likely that changes to government laws and regulations would be needed to ensure that rational package sizes would be used. Increased standardization and rationalization of consumer products might not be attainable without the imposition of government laws and regulations.

Most of the metric changes being sought for consumer products are to achieve objectives not related to the metric system, and some of the metric movements were influenced because producers believed that conversion was inevitable. The objectives sought, such as to provide for improvements in the fit of clothing, could be achieved without converting to the metric system. Whether they will be attained either with or without a conversion is open to debate.

For most consumer products and for activities such as sports, neither producers nor consumers will receive major benefits by converting to the metric system. Where benefits occur, they will be achieved only with much effort by those involved.

There is no compelling reason for many consumer products and some sports to convert to metric. Many consumer products are not exported to other countries; producers of those that are, seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to our size needs when necessary.

Those promoting metrication have stated that consumers will benefit. Rational package sizes, adopted for grocery products, will make price comparisons easier; and metric terms are easier to understand than certain of the customary terms. While the potential exists for establishing more

logical systems of package sizes and adopting measurement terms that could be more easily understood, these objectives can be achieved without converting to the metric system. Whether metrication would help these things happen is open to question. For some containers, such as cans, size conversions would require a considerable expense that quite likely would be passed on to consumers in the form of higher prices.

It may be that increased use of unit pricing would be of greater benefit to consumers than converting many products to metric. Increases in unit pricing would facilitate price comparisons and would be easier to understand. Also, unit pricing is not dependent on the use of standard or rational sizes which can be difficult and costly to achieve and would permit producers to make their products in sizes relating to their needs.

Under the current national policy, if the grocery products industry decides to voluntarily convert to the metric system, the U.S. Metric Board should work closely with industry, government, and consumer representatives to ensure that, when possible, rational size changes are made which benefit consumers.

If not, consumers might find it more difficult to make price comparisons than with the sizes now in use, such as occurred when the distilled spirits industry selected the 1.75 liter as the metric replacement for the 1/2 gallon (see ch. 26). Furthermore, metric terms are not understood by most Americans, and learning how to use them would require effort by almost all of them.

Producers' views in the food and apparel industries varied on whether to convert to the metric system, but support was prevalent. Large producers of food products believed that for their industry, the disadvantages of metrication would outweigh the advantages. Yet, most informed us they supported metrication. There was a strong feeling that conversion is inevitable, and most producers believed that, overall, conversion would be beneficial to the United States. In the apparel industry, major producers were hopeful that conversion would provide an opportunity to make desired improvements.

Several sports involved in international competition have already converted to the metric system because international and Olympic records are in metric; U.S. athletes should not be placed at a disadvantage when participating. But other sports, such as football, see no benefit and do not plan to convert. It appears these others will not convert unless required to by the Government.

The clothing industry has already expressed the need for Government funds to conduct a body measurement study so that metric clothing sizes can be developed. It is possible that other sectors will ask for Government aid.

If consumer products and activities, such as sports, are to be converted to the metric system, it must be because other more essential national objectives are being sought, such as making conversion to the metric system complete. Because the benefits of converting these to the metric system are so nebulous, the Board should give serious thought to how the average American consumer would be affected and whether conversion is necessary for the well-being of the consumer and the Nation.

CHAPTER 28

IS METRIC WEATHER IN THE FORECAST?

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IS METRIC WEATHER IN THE FORECAST?

The National Weather Service has developed a plan for converting weather information to metric terminology--scheduled to begin in June 1979. Although the plan will have its greatest impact on the public sector, it is not the public that has "voluntarily" made the basic decision to convert. Rather a Federal Government agency--the Department of Commerce's National Weather Service--is responsible. The plan is to be submitted to the U.S. Metric Board for approval.

REPORTING OF WEATHER INFORMATION

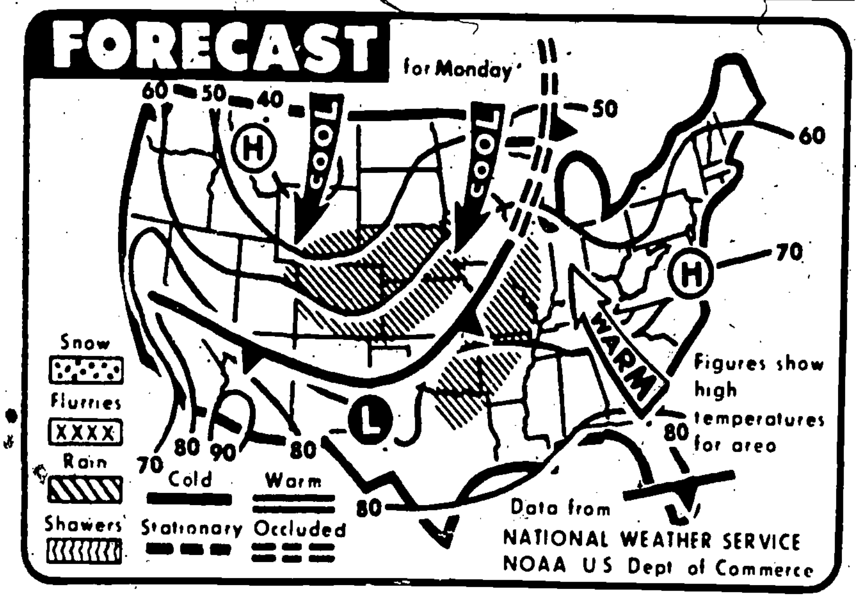
The metrication of weather will not change the weather, but will change the units that are now used to describe the weather. The kinds of weather information contained in the local newspaper would still be the same, but a new range of numbers would need to be learned for such items as temperature and precipitation. (See pp. 28-2 & 28-3.) For instance, 25 degrees would no longer be suitable for ice skating, but it would be okay for swimming.

Most weather information for the general public and specialized users, such as aviators and mariners, usually originates with the National Weather Service. This information is transmitted to the users through such avenues as the Weather Wire Service, which serves mass media by teletypewriter; the Federal Aviation Administration's Service A Teletypewriter system; the 24-hour Weather Radio broadcast system; and the Recorded Weather-by-Phone Systems.

Pleasure boaters generally rely on the Weather Radio system for their information. However, others, such as commercial shippers, rely on the Coast Guard's radio system because the Weather Service's system is limited in range. The Coast Guard receives its weather information from the Weather Service and makes some observations of its own.

In addition to the Weather Service, the FAA and the Department of Defense also make weather observations. The Weather Service receives the data collected and observed by both organizations in order to provide itself with as broad a data base as possible. Internationally, the information is exchanged through a world weather information system which uses a mixture of metric and nonmetric units--about a 50-50 split.

TODAY'S CUSTOMARY WEATHER REPORT



Local Weather

Fair today, highs in upper 60s. Clear and cool tonight, lows 45 to 52. Increasing cloudiness tomorrow, highs 72 to 76. Chance of rain is near zero through Monday night. Westerly winds 10 to 15 miles per hour today.

Temperatures

Yesterday's high was 72 at 3:45 p.m.; the low was 56 at 8:15 p.m. The high and low for Oct. 9, 1976, were 75 and 52. Normal temperatures for the date are 71 and 51.

Temperatures for Yesterday

Midnight	62	Noon	66
4 a.m.	64	4 p.m.	72
8 a.m	66	8 p.m.	57

Record Temperatures for the Year

Highest, 100 on July 6.
Lowest, 2 on Jan. 17.

Precipitation

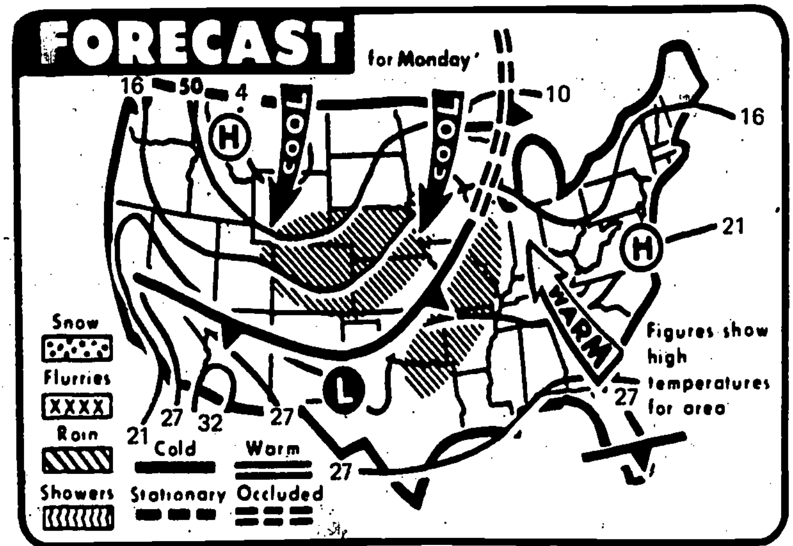
Yesterday's precipitation — 1.02 inch.

	1977	1976	Nor'l	30-year Rec'd	Yr.
January	1.50	3.56	3.03	5.08	'49
February	.66	1.55	2.47	5.71	'61
March	2.17	2.51	3.21	7.43	'53
April	2.66	1.17	3.15	5.97	'52
May	1.73	3.57	4.14	10.69	'63
June	3.28	1.21	3.21	11.53	'72
July	4.06	4.40	4.15	11.06	'45
August	4.70	2.13	4.90	14.31	'55
September	.32	7.23	2.97	12.36	'75
October	1.11	7.76	3.07	7.76	'76
November		.85	3.62	6.70	'63
December		1.99	2.78	6.54	'69

Temperatures in Various Cities

	H	L		H	L
Albany	62	48	Juneau	47	37
Albuquerque	74	48	Kansas City	61	34
Amarillo	70	48	Las Vegas	90	59
Anchorage	52	47	Little Rock	69	46
Asheville	65	52	Los Angeles	79	66
Atlanta	69	58	Louisville	54	44
Atlantic City	67	63	Memphis	66	48
Austin	80	64	Miami Beach	86	74
Billings	50	32	Midland-Odessa	70	55
Birmingham	64	57	Milwaukee	55	41
Bismarck	56	33	Mnpls.-St. Paul	55	34
Boise	61	35	Nashville	64	46
Boston	65	53	New Orleans	76	66
Brownsville	91	75	New York	65	60
Buffalo	55	48	Norfolk	71	65
Burlington	57	47	Oklahoma City	73	40
Casper	61	38	Omaha	63	32
Charleston S.C.	78	72	Orlando	90	69
Charleston W.Va.	51	47	Philadelphia	67	55
Charlotte N.C.	79	62	Phoenix	92	70
Cheyenne	63	37	Pittsburgh	50	46
Chicago	55	46	Portland Me.	59	47
Cincinnati	51	44	Portland Ore.	62	43
Cleveland	51	45	Providence	65	54
Columbia S.C.	81	63	Raleigh	73	63
Columbus	50	45	Rapid City	62	33
Dallas-Ft. Worth	78	45	Reno	73	31
Dayton	49	44	Richmond	74	60
Denver	74	61	St. Louis	59	43
Des Moines	60	37	St. Prbg.-Tampa	87	68
Detroit	48	42	Salt Lake City	68	40
Duluth	50	34	San Antonio	80	65
El Paso	64	58	San Diego	73	68
Fairbanks	49	35	San Francisco	65	54
Fargo	58	33	San Juan	86	76
Flagstaff	69	36	St. Ste. Marie	44	42
Great Falls	36	32	Seattle	58	46
Hartford	63	50	Shreveport	78	52
Helena	49	39	Sioux Falls	62	29
Honolulu	86	70	Spokane	51	40
Houston	77	63	Syracuse	63	49
Indianapolis	53	46	Tucson	82	67
Jackson Miss.	72	57	Tulsa	73	41
Jacksonville	83	69	Wichita	75	41

TODAY'S METRIC WEATHER REPORT



Local Weather

Fair today, highs 19 to 21. Clear and cool tonight, lows 7 to 11. Increasing cloudiness tomorrow, highs 22 to 24. Chance of rain is near zero through Monday night. Westerly winds 16 to 24 km per hour today.

Temperatures

Yesterday's high was 22 at 3:45 p.m.; the low was 13 at 8:15 p.m. The high and low for Oct. 9, 1976, were 24 and 11. Normal temperatures for the date are 22 and 11.

Temperatures for Yesterday

Midnight	17	Noon	19
4 a.m.	18	4 p.m.	22
8 a.m.	19	8 p.m.	14

Record Temperatures for the Year

Highest, 38 on July 6.
Lowest, -17 on Jan. 17.

Precipitation

Yesterday's precipitation—2.59 cm

	1977	1976	Nor'l	30-year Rec'd	Yr.
January	3.81	8.04	7.70	12.80	'48
February	1.88	3.94	8.27	14.80	'61
March	8.81	8.38	8.18	18.87	'53
April	6.78	2.87	8.00	16.18	'52
May	4.38	8.07	10.82	27.18	'83
June	8.33	3.07	8.18	29.29	'72
July	10.31	11.18	10.84	28.09	'46
August	11.84	8.41	12.46	38.38	'56
September	.81	18.36	7.84	31.39	'75
October	2.82	19.71	7.80	18.71	'78
November		2.18	8.18	17.02	'83
December		8.05	7.08	18.61	'89

Temperatures In Various Cities

	H	L		H	L
Albany	17	8	Juneau	8	3
Albuquerque	23	9	Kansas City	16	1
Amarillo	21	9	Las Vegas	32	15
Anchorage	11	8	Little Rock	21	8
Asheville	18	11	Los Angeles	26	19
Atlanta	21	14	Louisville	12	7
Atlantic City	18	17	Memphis	19	9
Austin	27	18	Miami Beach	30	23
Billings	10	0	Midland Odessa	21	13
Birmingham	18	14	Milwaukee	13	5
Bismarck	13	1	Mnpls.-St. Paul	13	1
Boise	18	2	Nashville	18	8
Boston	18	12	New Orleans	24	19
Brownsville	33	24	New York	18	16
Buffalo	13	9	Norfolk	22	18
Burlington	14	8	Oklahoma City	23	4
Casper	18	3	Omaha	17	0
Charleston S.C.	28	22	Orlando	32	21
Charleston W.Va.	11	8	Philadelphia	18	13
Charlotte N.C.	26	17	Phoenix	33	21
Cheyenne	17	3	Pittsburgh	10	8
Chicago	13	8	Portland Me.	18	8
Cincinnati	11	7	Portland Ore.	17	6
Cleveland	11	7	Providence	18	12
Columbia S.C.	27	17	Raleigh	23	17
Columbus	10	7	Rapid City	17	1
Dallas-Ft. Worth	26	7	Reno	23	-1
Dayton	8	7	Richmond	23	18
Denver	23	18	St. Louis	16	8
Des Moines	18	3	St. Ptrsg.-Tampa	31	20
Detroit	8	8	Salt Lake City	20	4
Duluth	10	1	San Antonio	27	18
El Paso	18	14	San Diego	23	20
Fairbanks	8	2	San Francisco	18	12
Fargo	14	1	San Juan	30	24
Flagstaff	21	2	St. Ste. Marie	7	8
Great Falls	2	0	Seattle	14	8
Hartford	17	10	Shreveport	26	11
Helena	8	4	Sioux Falls	17	-2
Honolulu	30	21	Spokane	11	4
Houston	26	17	Syracuse	17	8
Indianapolis	12	8	Tucson	28	19
Jackson Miss.	22	14	Tulsa	23	8
Jacksonville	28	21	Wichita	24	8

Note: This Chart Reflects The Metric Equivalents Of The Data Shown On The Previous Page.

CURRENT CONVERSION ACTIVITIES

The National Weather Service anticipated Federal legislation on metrication and began planning for conversion of public weather reporting. It even began some conversion activities before passage of the December 1975 Metric Conversion Act.

In 1974 the Weather Service authorized its offices along the Canadian border to give temperatures in dual terms when necessary and warranted. It did this in anticipation of Canada's conversion of weather information to metric that was to begin in April 1975. Because radio and television stations in the United States and Canada rely on advertising directed at audiences on both sides of the border, it was felt that these stations should be provided the option of reporting weather in metric terms.

Although Mexico is metric, the question never came up; therefore, authorization for dual reporting was not granted to the Weather Service's offices along the Mexican border. However, in 1976, the Service extended the authorization and made dual reporting of local temperatures optional for all its offices.

In June 1975 the Weather Service started giving daily temperatures in Celsius only--the way they were received--for select foreign cities over its wire service. By July the Service had decided to revert to Fahrenheit because of considerable opposition from the media. However, in August 1975, the Weather Service decided to give dual temperatures which is now the current practice. The Weather Service has received opposition from newspapers because of space problems in giving both Celsius and Fahrenheit. Generally, the newspapers' solution has been to report these temperatures in Fahrenheit only.

In the summer of 1976, the National Weather Service started providing both Fahrenheit and Celsius temperatures in its hourly forecasts over the wire service. It did this to reduce conversion errors made by the media and to save time for the media. When severe weather warnings are given, however, the Celsius is dropped because of time considerations.

PUBLIC PLAN

Weather Service officials told us that they believe the Congress intended, by passing the Metric Conversion Act of 1975, that the United States convert to the metric system as soon as practical. Therefore, the Weather Service is preparing for conversion.

The Weather Service believes conversion is voluntary to the extent that, as a service organization, it will provide whatever is demanded--customary only, metric only, or both. The demand for public weather information, it believes, comes from the media, which, in turn, receives its demand from the public. Essentially, the Weather Service considers the media to reflect the public's opinion.

Weather Service officials told us that the decision to implement a plan for converting weather reporting rests with the U.S. Metric Board and the media, in as much as either one could prevent the plan from being implemented. The basic authority to use metric units rests in the 1866 Act.

On June 14, 1977, the National Weather Service announced its proposed plan to use metric terminology in issuing weather information to the public. As a result of a June 30, 1977, public hearing and other additional input, the plan was modified slightly and reissued in October 1977.

The plan does not apply to aviation or marine weather reporting. Before conversion to the metric system can occur in these sectors, international agreements will need to be changed. The public weather reporting units that will be used are shown below.

Units for Use in Public Weather Reporting

TEMPERATURE RELATED ELEMENTS

C DEGREES CELSIUS

SPEED RELATED ELEMENTS

km/h KILOMETERS PER HOUR

PRECIPITATION RELATED ELEMENTS

cm CENTIMETERS FOR ALL PRECIPITATION

cm/h CENTIMETERS PER HOUR FOR RATES

PRESSURE

kPa KILOPASCALS

DISTANCES

km KILOMETERS

HEIGHTS

m METERS AND KILOMETERS

SUNSHINE DURATION

PERCENT OF MAXIMUM POSSIBLE ON A CLOUD-FREE DAY AT A GIVEN SITE

DIRECTION

DEGREES OR POINTS OF COMPASS

LOCATION

DECIMAL DEGREES OF LATITUDE AND LONGITUDE OR DIRECTION AND DISTANCE FROM A LOCATION

SOLAR RADIATION

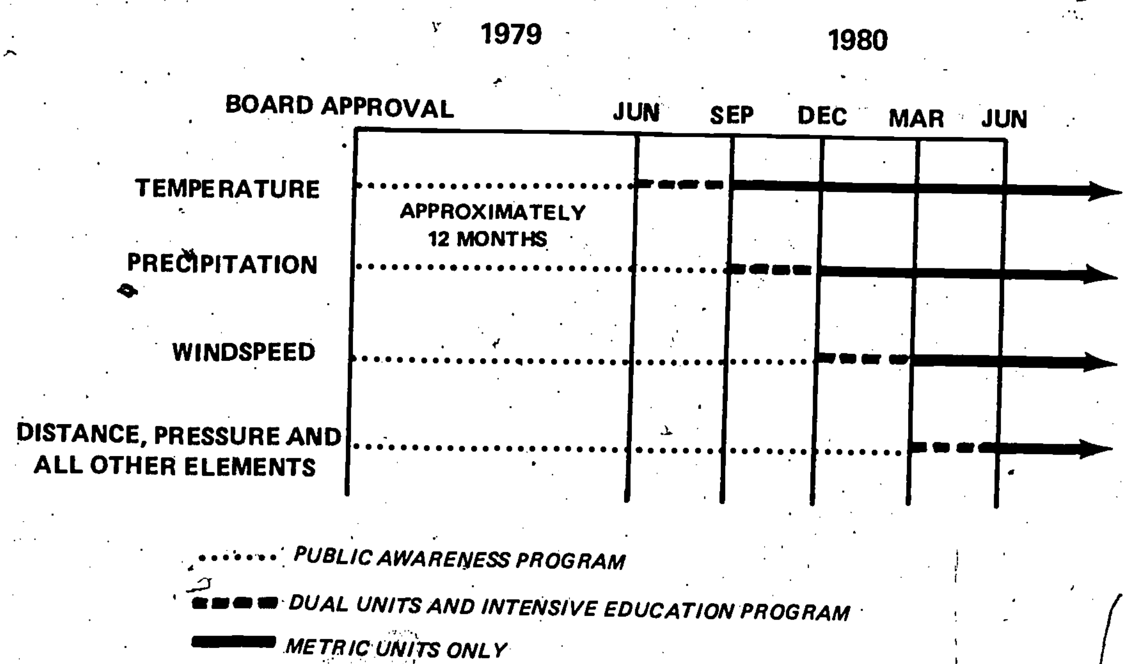
kWh/m^2 KILOWATT-HOURS PER SQUARE METER

Under the original plan, conversion was to begin in June 1978, and be completed by January 1, 1979. Under the revised plan, conversion is to begin in June 1979, and be completed by June 1, 1980. These dates could be changed again because before the plan is implemented, it must be sanctioned by the U.S. Metric Board.

As shown below, metric terminology would be phased in gradually with 3-month periods of dual reporting; then metric only would be used.

Proposed Metrication Of Weather Reporting To The Public

Conversion Schedule



The Weather Service has no detailed plans for educating the public; rather, it has a general plan. The general plan is to have the media and any other interested parties take the responsiblity and initiative--as a public service--for educating the public. The Weather Service sees its role in educating the public as one of an information source for the media and others. It would provide press releases; spot announcements; assistance in putting together newspaper and periodical articles; and speakers and materials for the media, schools, and civic organizations.

The Weather Service's field offices would be available to assist in the areas they serve to the fullest extent

possible. The Weather Service had expected the Federal Highway Administration's proposed conversion of speed limit signs to be implemented and thus aid in educating the public in metric terms. However, the Federal Highway Administration has withdrawn its proposal; and thus, this educational aid may not be available. (See ch. 10.)

Comments on the plan

Although the Weather Service has more contact with the public through its weather information than many Federal agencies, it has moved ahead with metrication with no direct attempt to gain direct input from the general public as to how and when, if at all, conversion should take place.

The Weather Service contracted with the American National Metric Council to assist it in obtaining evaluation comments on its original plan. Under the contract, ANMC was to circulate the draft proposal to all "affected" parties with a request that they respond with written comments. In addition, parties "affected substantially" by the change were invited to participate in a June 30, 1977, public meeting, at which time they would be given an opportunity to comment orally on the proposal.

The determination of which parties were "affected" and "affected substantially" was made by ANMC and the Weather Service. The list of affected parties consisted of seven categories: Radio/TV and Communications, Press, Consumer Affairs Reporters in the Washington News Bureau, Consumer/Education, Manufacturers, Travel/Aviation, and "Others."

The Council agreed to compile and analyze the written responses and present a report to the National Weather Service, including the raw data, the analysis, and the results of the meeting. The public meeting was announced in the June 23, 1977, "Federal Register;" however, the proposed plan did not appear in it. Instead, the Weather Service relied on ANMC and a press release to inform the public

ANMC's analysis stated that:

> "* * * the National Weather Service proposal received favorable responses from all affected parties. Official comments solicited by ANMC that expressed opinions in favor or opposed were 49 to 6 in favor of the NWS [National Weather Service] Metrication Plan."

The analysis also commented on the 370 general public responses received as a result of media coverage.

> "Well over 50 newspaper articles explained the plan to the general public. Public comments ran slightly over 2 to 1 opposed except in two metropolitan areas. A Dallas, Texas, campaign produced 215 letters, virtually all negative and a St. Paul, Minnesota, newspaper campaign drew 110 letters opposed. In those areas, responses were overwhelmingly opposed due to either negative or biased reporting by the news media. * * *These letters do not represent any valid poll of opinion of the general public concerning metrication or the NWS [National Weather Service] proposal. The public for the most part remained fairly quiet and did not respond to this plan."

We agree that the letters do not represent a valid poll of the general public concerning support or opposition to the plan, but neither the Weather Service nor ANMC attempted to obtain a valid or reliable assessment of public opinion. If the responses from the two metropolitan areas mentioned above are not counted, only 45 public responses were received by ANMC. According to a Weather Service official, public responses sent directly to the Weather Service on its original plan have been light but most of these responses have opposed the plan.

Comments by those receiving the draft plan from ANMC dealt mainly with the plan's timing, its impact on the public, and its proposed terminology.

Timing

The comments brought out basically two theories on the timing of the metrication of weather information. One was that a truly gradual changeover would aid the public in understanding metric weather in that it would slowly but surely associate customary with metric measurements. The other was that an immediate changeover would force the public to learn and use metrics. The Weather Service's plan is a compromise between the two. The period of dual reporting for any given segment, such as precipitation, is short; but the entire conversion is over a longer period.

The timing in the proposed plan was endorsed by many of those responding, but it did draw criticism. No matter which approach--gradual or immediate--was endorsed by those responding, many of them expressed concern over the need to educate and prepare the public adequately before the change takes

place. Under the revised plan, the dual reporting period of 1 month for temperature and 2 months for the other elements was increased to 3 months, and the overall conversion period was increased from 7 to 12 months.

It has been stated that if the period of dual reporting is too long, as in the case of the United Kingdom, people will ignore metric and use customary terms. Canada and Australia on the other hand, had short conversion periods and were considered to have successful conversion programs. In Canada there was concern that there would be a great public uproar when temperature was converted to Celsius, but according to the Canadian Metric Commission, when only Celsius was reported on April 1, 1975, nothing happened--only a few "odd calls."

The success of Canada's conversion was attributed to a massive public education campaign launched through the mass media. The Canadian Metric Commission provided the media with educational materials (posters, film strips, etc.) and held seminars across the country for them. The Commission made sure that farm groups, the media, consumer organizations, and all who should know about metrication were informed. Only metric terms were used in these materials--no equivalent customary units were shown; otherwise, the Commission believed the public would ignore the metric units and not learn the metric system.

However, about 20 percent of the Canadian radio and TV stations have reverted to dual reporting. These stations are along the U.S. border and in areas with concentrations of elderly people. The Commission expects that these stations will, over time, convert to metric only.

Terminology

Concern was expressed over some of the units in the proposed plan. The proposed unit for solar radiation, watt-hours per square meter, drew criticism because it is not a basic unit. Some expressed a preference for either joules per second per square meter or kilojoules per second per square meter. Another unit that received similar concern was the proposed unit for windspeed, kilometers per hour. The unit meters per second is a preferred unit in the International System of Units system; however, kilometers per hour was proposed because it is easily related to such things as speed limits.

Concern was also expressed over the original proposal to use two units instead of one for reporting rainfall and snowfall. Millimeters were to be used to measure rainfall; centimeters, to measure snowfall. It was felt that this might be confusing and awkward for the news media to report.

The Weather Service has now modified its plan, and centimeters is the proposed unit to be used for all precipitation.

One unit that generated much discussion was the unit for barometric pressure, the SI metric unit "kilopascal." The alternative units suggested were the millibar and millimeters of mercury. It was suggested that the public could more easily relate to millimeters of mercury because it is similar to the current practice of using inches of mercury. One argument for the millibar was that, although it is not an SI unit, it has been used by meteorologists for a long time. The World Meteorological Organization has adopted it as the standard unit for pressure and has not made any indication of changing.

It has also been argued that the kilopascal should be adopted because it will probably become the term used for such things as tire pressure, water pressure, and other measures where pounds per square inch are now being used. By adopting the kilopascal now, it is argued, instead of the millibar or millimeters of mercury, only one change will be made instead of two. The Weather Service has proposed that the kilopascal be used.

Weather records

Weather data accumulated over the years (archived data) is used to help forecast the weather and help utilities project how much electricity or gas will be consumed on a given day or period. In making a projection, both the forecast and archived weather data are used. The National Weather Service is not going to convert archived data to metrics; instead, it will compute in customary units and then convert the results.

A Weather Service official told us this approach will be of a minimal cost, requiring only a small amount of computer time. There will be some problems with data that has been published; it will have to be converted by the user.

FEDERAL PLAN

As noted previously, the Weather Service's plan to convert to metrics applies to the public sector only. The Weather Service also provides weather information to the Department of Defense, the FAA, the marine community, and various world weather organizations which also provide weather data to their respective users. Accordingly, the Weather Service through an interdepartmental committee, is in the process of developing a plan for the conversion of meteorological information exchanged between Federal agencies.

The conversion of weather information and equipment within each agency will remain the responsibility of that agency. Each agency will also be responsible for planning and implementing metric conversion with their users.

In developing this Federal metrication plan, regulations and resolutions of the World Meteorological Organization, the International Civil Aviation Organization, and the Intergovernmental Marine Consultative Organization will be given consideration. These international organizations are using a combination of SI metric, non-SI metric, and customary units.

It is anticipated that the same metric units eventually will be used in the Federal system; but until international agreements are reached for aviation and international marine purposes, current units will continue to be used as follows. Visibility will be expressed in miles; wind speed, in knots; heights for aviation, in feet; pressure, in millibars; and altimeter settings, in inches of mercury.

One metrication problem in aviation is the cost of converting instrumentation. Metric units cannot be used before the instrumentation is converted without increasing safety hazards. The National Weather Service estimates that it would be 1985 before general aviation could be converted. (See ch. 15 for a discussion on aviation.)

COST AND BENEFITS OF CONVERSION

The National Weather Service, being basically scientific and used to working with both metric and customary units, can easily convert from one to the other. It has been making conversions in reporting to the public, aviation, marine sectors, and world weather organizations; and it will continue to do so.

The Weather Service officials saw no great short-term benefits from the planned conversion. In the long run they expected some benefits for the Service through the use of a consistent measurement system. With respect to the general public, they saw benefits from the conversion of weather reporting as arising only as part of an overall conversion to the metric system which they considered to be a simpler system.

Federal

Most of the Weather Service's equipment is in conventional units and would eventually have to be replaced with metric equipment. However, through the Weather Service's 1979 budget, no funds have been requested for equipment

replacement. The Weather Service estimates that it will cost about $3 million to retrofit observation equipment; i.e., replace readouts, dials, scales, etc; and purchase some new equipment. In some instances, it will have to replace items before they are fully depreciated because the equipment and readouts must be consistent. The Weather Service officials were unsure what assumptions were made in arriving at this figure, but assumed it represented the total conversion cost.

Thus far, the Weather Service has been talking about language changes only. It has not considered going back and replacing equipment now in service. This could be costly. The current policy is to purchase all new equipment that has a life cycle of 5 years or more with metric or dual readouts if the cost of such equipment does not exceed the cost of equipment with customary readouts. According to the Weather Service, the cost of metric equipment has been the same as the cost of customary equipment.

The Weather Service's Equipment Development Laboratory has implemented a metric mechanical engineering drafting policy. The policy, which became effective January 1, 1977, calls for all drawings, sketches, and illustrations to be dimensioned using SI; no dual dimensions will be used. All ongoing projects will be finished using customary units, and no completed jobs will be redone in metric.

Industry

Manufacturers of weather instruments generally have been exposed to metric. According to one manufacturer, the industry has been supplying weather equipment to the United Kingdom and Canada for about 10 years. Many companies are producing equipment with dual scales at little or no additional costs. The time and temperature signs commonly seen at banks have in many cases been converted to readout in both Celsius and Fahrenheit. The cost to convert these signs is relatively small. The main concern of the manufacturers, however, is that adequate lead time be given for conversion and that the acceptable units are clearly stated.

Public

The Weather Service has not estimated the cost of metrication to the public because it believes there will not be much cost. The Weather Service believes the public will buy some new equipment, such as thermometers, as the result of conversion; but does not believe the purchases will be extensive. Rather, it believes the public will use conversion charts or overlays to convert the scales on its present equipment. We are not as sure as the Weather Service that

it will not directly or indirectly prompt consumers to make extensive metric purchases.

When Canada converted, thermometer sales increased significantly. One manufacturer doubled its previous year's sales. This same manufacturer felt that the conversion of weather reporting in the United States would also result in increased sales but probably not to the extent they increased in Canada.

Public educational or awareness programs used to prepare and aid the public in converting is also a cost of metrication. Whether the Weather Service or the media or some combination of the two provides these programs, the cost, we believe, will eventually be borne by the public.

COORDINATION OF CONVERSION

As pointed out, the National Weather Service is moving ahead with conversion in the public sector and not waiting for conversion in the specialized sectors, such as marine and aviation. The Weather Service believed it could not convert in these areas at this time because of international agreements. It believed it should comply with what it thought was the intent of the Congress and get on with metrication.

However, some responses concerning the Weather Service's proposed plan expressed a need for coordination throughout government, industry, education, and the general public. The concern for coordination was not directed just at the Weather Service's effort; it was also directed at any national metrication effort. The concern over government involvement is that the metric conversion policy should be set by one official body, coordinated with all segments of the economy, so that policies and plans of one group or several subgroups do not go into effect without proper coordination. Another concern is that conversion policies be uniform throughout all government to facilitate dealings.

Coordination with industry is important so that the industry can have sufficient lead time to prepare for conversion. Coordination of education is important in that it is to a person's advantage to have what is taught to him in school coincide with what he encounters outside of school. Coordination with the general public is critical because the acceptance or rejection of public weather reporting will determine the success of the Weather Service's efforts to truly "serve" the public.

As noted earlier, the Weather Service has not presented its plan directly to the general public. However, it has

contacted the media, which it feels represents the public because the media is the public's source for weather information. Accordingly, on October 17, 1977, the Weather Service and ANMC signed an agreement to have ANMC, with the aid of the National Association of Broadcasters, survey station owners and managers concerning the Weather Service's plan.

With respect to obtaining public comment, Weather Service officials informed us that they believed their actions--distribution of the plan to the media and holding the public hearing--were adequate. They saw little to be gained from holding additional hearings or conducting more opinion surveys. They recognized, based on surveys done by others and the public response resulting from media reporting on the proposed plan, that the public was not favorable toward metrication. However, they believed the important question was whether the public would accept metrication with reasonable ease after a public education program, after some exposure to metrication, and after it was clear that the Nation was moving toward metrication. This question, they believed, could not be answered through hearings or opinion surveys. Therefore, in keeping with their opinion that a national decision had been reached to convert to the metric system, the Weather Service proceeded with the development of the plan for conversion. To do otherwise, they believed, would have been irresponsible.

CONCLUSIONS AND RECOMMENDATIONS

Conclusions

The Weather Service's proposed plan to convert weather reporting to metric units points out a weakness in the theory that metric conversion can be voluntary, particularly for the individual. If the Weather Service does convert, the public will have little choice but to learn and use metric units.

If the Weather Service does not convert, then those segments of the public that want to receive metric weather reports will not receive them. If the Weather Service chooses to report in both metric and customary units, it could undoubtedly receive opposition from the news media as it did in the past, even though the media can choose how they report it--metric, customary, or both.

The actions of one organization which, in effect, force metrication on others is not unique to the Weather Service or to certain other Federal agencies. The same situation can occur in the private sector when a major firm decides to convert to metrics. This decision may force some of its suppliers to convert also.

Because the role of Government agencies, including the Weather Service, is not set forth in the Metric Conversion Act of 1975 or its legislative history, each agency determines its own course of action in converting. We believe the Congress or the executive branch should establish what the role of Government agencies, if any, will be in conversion. As one Weather Service official said, an explicit policy to go or not to go metric would help.

From the evidence presented by the Weather Service and others, particularly with respect to benefits, we believe that in the absence of a clear public demand or a national policy to convert to the metric system, the reporting of weather data to the general public in metric terms is not warranted at this time.

The Federal Government is the main source of weather data, and the National Weather Service is the primary source within the Federal Government. The Weather Service has been using both customary and metric terms in its internal operations for years; therefore, conversion, if it takes place, will be relatively simple for it. The impact on manufacturers of weather equipment, if given sufficient lead time, should be minimal. The impact on the public will be the inconvenience of becoming familiar with new units; the cost of educational programs; and the cost of replacement--at the individual's discretion--of weather instruments, such as thermometers. Actual experience in Canada showed that the public did buy new thermometers. The proposed plan for public weather reporting was generally accepted by those to whom it was presented; however, comments received by the Weather Service from the general public generally were not favorable.

Apart from its educational value as a method of teaching metrics, when and if the country converts, conversion of public weather reporting offers no real advantages to the public and will undoubtedly involve some additional costs. Therefore, the public sector should have the opportunity to comment on any proposed plan that would have an impact on them, perhaps through public hearings in various parts of the country. It can best be summed up as one television weatherman asked,

> "Do we really serve the public by reporting information using a system which, while it may be more logical and universal, is still unfamiliar, confusing and resented by those it is meant to inform and serve?"

Recommendation to the Secretary of Commerce

We recommend that the Secretary instruct the National Weather Service to delay implementing the proposed plan for metrication of weather reporting until there is a clear public demand or a firm national decision to convert to the metric system.

AGENCY COMMENTS

A draft of this chapter was discussed with officials of the National Weather Service, the National Oceanic and Atmospheric Administration, and the Department of Commerce. These officials generally disagreed with our recommendation.

It was their position that metric conversion has been declared to be in the best interests of the United States; that the Metric Conversion Act of 1975 constitutes a national decision to convert to the metric system; and that the Department is committed to conversion. They also believed that a clear public demand for conversion would be far in the future and to wait for this demand would mean conversion would not occur. Accordingly, in keeping with these views, the Weather Service proceeded with the development of the conversion plan.

By letter dated May 19, 1978, the Assistant Secretary for Administration, Department of Commerce, transmitted the National Oceanic and Atmospheric Administration's written comments on our draft report. It disagreed with our recommendation and stated the following:

> "NOAA [National Oceanic and Atmospheric Administration] does not see a justification for this recommendation. No national decision beyond the Metric Conversion Act of 1975 is anticipated or foreseen, nor is a 'clear public demand' likely to arise in the foreseeable future. To wait for either of these conditions as the draft report proposes would constitute unresponsiveness toward the Metric Conversion Act of 1975, which was passed without a clear public demand."

The Atmospheric Administration also stated that the act constitutes a national decision to support increased use and understanding of the metric system. According to an official this view is more in tune with the intent of the act than the view held while developing and promoting their plan. The Atmospheric Administration now interprets the act as being stimulative and encouraging metric conversion.

The Atmospheric Administration further stated that the Weather Service always intended and still intends to submit their plan for metric weather information to the Department of Commerce and to the U.S. Metric Board for comments, suggested changes, and approval. They established a tentative schedule for internal planning purposes to avoid long delays once the above coordination has been completed and to be more responsive if users, such as the media, request that weather information be provided them in metric units.

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The act does not provide a national commitment to convert to the metric system, nor does it intend that Federal agencies encourage, advocate, or compel metric conversion. It does not stipulate whether the customary or metric system should be the predominant measurement system for use in the United States. The act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected.

The voluntary aspect is particularly important when a Federal, State, or local government agency voluntarily takes or proposes metric conversion actions which change the measurement system used by large portions of the general public. Thus, the voluntary decision by Government, in effect, becomes mandatory on the general public.

CHAPTER 29

CONVERSION WOULD HAVE WIDESPREAD LEGAL IMPLICATIONS

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MANY LEGAL REVISIONS WOULD BE NEEDED

Many laws, regulations, ordinances, and codes at all levels of Government contain measure-sensitive provisions. These include: laws, such as those governing the speed limits on our roads and highways, the terms and conditions under which consumer products are sold, building codes, freight tariffs, and taxes based on the measure of various products. Metrication would require the need to review them to determine exactly what changes would have to be made in order to adopt the metric system.

For example, the metric equivalent of the 55-mile-per-hour speed limit is 88.5 kilometers an hour. If highway speeds are ever converted to metric, the 55-mile-per-hour speed limit would most likely be converted to 90 kilometers an hour. Conversion of highway speeds would also involve the need to coordinate the conversion of other Federal, State, and local government traffic enforcement laws. (See ch. 10.)

State and local government building codes are another example. It is likely that a building code that now requires an 8-foot minimum ceiling height (2,438 millimeters) would be converted to prescribe a minimum ceiling height of 2,400 millimeters. Factors, such as the sizes of paneling and lumber, would need to be considered before changing the codes. (See ch. 16.)

The U.S. metrication policy provides for voluntary conversion to the metric system. Under this policy, laws and other legal requirements will be converted as the legislative and administrative organizations see the need to convert. However, conversion actions which are voluntarily made by government may not result in conversions which are voluntary for society because if a government converts a provision to metric, its use may become mandatory for others.

Confusion could occur and the position of government could be viewed as inconsistent if some legal provisions are converted and others are not. In some instances governments may be able to show measurement-sensitive provisions in both customary and metric measurements as an alternative.

Since government laws, regulations, ordinances, and codes affect so many of the activities undertaken by businesses, any

changes should be coordinated with the conversion activities of the industries affected. Care would be needed to ensure that uneconomical conversions are not forced on industries by legal changes which would require sectors to convert and that the health and safety of the public would not be endangered by the changes. For example, the Federal Aviation Administration recognizes that air safety could be jeopardized during a conversion. Before it would convert its air operations regulations, the impact of conversion would require indepth system analyses to ensure that the safety of airline passengers and crews is protected. (See ch. 15.)

Searching the laws, regulations, and other legal citations to determine the measurement-sensitive provisions would be a formidable task. However, the task may be eased to the extent that the citations needing change could be identified using computer systems. Several computerized retrieval systems exist which contain laws, regulations, and other legal references. For instance, the U.S. Air Force operates a computerized legal research service which can locate references to terms, such as meter and foot, that are in the U.S. Code, the Armed Services Procurement Regulation, and other legal sources. Also, several firms have the capability of retrieving various types of legal data. But search of much material may have to be done manually.

One of the ascribed benefits of metrication is that it causes organizations to take a new and critical look at their activities and to make other desirable changes, such as revising or deleting things which have become obsolete, but metrication is not necessary to make such changes. Critical reviews would need to be made of legal provisions before converting them to metric in order to achieve this potential benefit. Because the United States does not have a firm Government commitment to convert and guidance has not been provided to Government agencies by the Office of Management and Budget, no coordinated effort has been undertaken to determine the legal changes that a metric conversion would entail and whether benefits could be achieved.

Governments in several other countries have established a firm commitment to convert to the metric system. (See ch. 30.) In carrying out this commitment, they undertook programs to convert the measurement-sensitive provisions in their laws. For instance, the Canadian Government plans to enact four omnibus laws to change the measurement-sensitive provisions in its laws. The first omnibus law, which was enacted in August 1977, covered measurement terms used in packaging and labeling consumer products, bulk grain activities, and retail scales. This technique streamlined the process of amending measurement-sensitive laws.

ANTITRUST LAWS--A CONCERN IN SOME FIRMS

Various officials believed there was danger that actions taken to reach agreements for orderly industry conversions could be interpreted as being antitrust in nature, subjecting participants to lawsuits by those who believed they were harmed. Some officials believed metric conversion activities should be exempted from the Sherman Anti-Trust Act's provisions. Other officials, however, did not believe metrication activities would subject their firms to the possibility of antitrust suits.

When the Congress was considering legislation on converting the United States to the metric system, it considered including provisions to provide industries immunity from the antitrust laws for their activities of informing and advising the U.S. Metric Board on conversion plans. But the Metric Conversion Act of 1975 enacted by the Congress does not contain any provisions which give participating companies immunity from the antitrust laws. Firms, however, should not presume that participation in the metrication activities contemplated in the Metric Conversion Act will necessarily constitute an antitrust violation.

On the other hand, because adoption and implementation of an industrywide conversion plan may require consultation and collaboration among competitors, metrication activities do provide competitors an opportunity to engage in restrictive or anticompetitive practices that may violate the antitrust laws. Antitrust problems could arise if dominant members of an industry seek to drive smaller competitors out of business by imposing standards that smaller businesses cannot afford or by adopting an unreasonably short conversion period. Thus, industries that are contemplating conversion to the metric system should not ignore antitrust considerations.

The Department of Justice Antitrust Division has advised business that when proceeding with plans to convert to the metric system, the following precautionary measures are recommended.

--Consult counsel. Interfirm conversion activities should not be undertaken without the advice of legal counsel.

--Consider consulting with the Department of Justice or the Federal Trade Commission on the proposed course of action for evaluation of the conformity with antitrust laws.

--Subject proposed standards or conversion schedules to the scrutiny of a wide cross section of interested persons.

--Work with the U.S. Metric Board.

--Industry conversion standards should provide for gradual conversion with consideration given to the needs of small business.

--Conversion standards and timetables should be voluntary.

Determinations of antitrust violations are made by the courts on a case-by-case basis and frequently entail complex economic analyses of particular industries. It is virtually impossible to describe with any degree of specificity the conversion-related activities that may create antitrust problems.

In determining whether the antitrust provisions of the Sherman Act have been violated, the courts apply two basic standards depending on the type of anticompetitive behavior involved. In most cases the "rule of reason" is applied under which the courts consider all pertinent facts and circumstances surrounding a particular restraint of trade to determine whether the restraint is reasonable.

The second legal standard applied is the "per-se rules." These apply only to limited types of anticompetitive behavior--most notably, price-fixing, group boycotts, tie-in sales, and market allocations. In these cases it is not necessary to demonstrate the unreasonableness of the restraint of trade through a detailed analysis of the restraint and the industry involved.

CHAPTER 30

LESSONS LEARNED BY FOREIGN COUNTRIES

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At the time the International System of Units was adopted, the principal countries not using some form of the metric system were the British Commonwealth and former Commonwealth nations and the United States. These countries had not converted to the metric system because they had an established uniform system of weights and measures within their countries and most of their trade had been with each other. Some of these nations--Australia, Canada, New Zealand, and the United Kingdom--since that time have converted or are in the process of converting to the metric system.

Regardless of the differences in physical and economic characteristics and types of governments between these countries and the United States, each country's metrication experience can provide valuable assistance if the United States decides to convert. These experiences have shown that the following principles should be adopted if the United States converts to a predominantly metric system of measure in an efficient manner.

--A firm Government commitment to convert is necessary.

--A central body should be established early to plan and coordinate the conversion and inform the various sectors of the economy and the public of metric activity.

--A well-developed plan and effective coordination by industry and all sectors of the economy must be accomplished.

--A voluntary conversion must eventually become mandatory through laws and regulations, etc., in order to complete the metrication program.

--Overall and specific target dates must be used.

--The public must be adequately informed and educated, and responses must be made to consumer concerns because conversion of the retail sector is most difficult.

--Letting costs lie where they fall can be adopted in whole or in part.

--Government purchasing power can be used to propel the conversion.

--The conversion of certain sectors, such as sports and weather forecast, can aid in metric education.

--Periods of dual marking should be kept to a minimum.

--Hard conversion of products is more desirable than soft conversion whenever practicable to obtain benefits.

We reviewed the four country's metrication efforts on the basis of information provided by its metric boards or commissions, and each country's officials reviewed our summary of its experiences and lessons. The data we obtained was not evaluated in detail for its validity. In addition, we visited the United Kingdom and Canada where we met with Government and private industry officials.

BACKGROUND OF CONVERTING NATIONS

Important conversion dates for each country we reviewed are shown in the following table.

Country	Date of decision to convert	Date metric organization first met	Target date of completion
Australia	June 1970	July 1970	1980
Canada	Jan. 1970	Jan. 1972	1980
New Zealand	Feb. 1969	Nov. 1969	1976
United Kingdom	May 1965	May 1969	1975

New Zealand has met its target date and Australia is moving on schedule. Although metrication progress is being made in Canada, it is uncertain whether its target will be met because, among other things, certain elements will have to be coordinated with a U.S. conversion. The United Kingdom did not meet its target date of 1975; it will be sometime in the early 1980s before its conversion will be completed.

These countries began converting principally because of international trade. The United Kingdom's conversion, which began a chain reaction of other countries, was influenced by the amount of trade it was doing with metric countries, especially the members of the European Economic Community which it later joined. Each country believed the others were going to convert and therefore, the international trade reason

became more important to them. Also, each country was trading more with other metric countries.

There is a difference between these countries and the United States in the area of trade and its relationship to the countries' gross national product. For example, the United Kingdom's and Canada's exports represent about 20 and 18 percent of their gross national product, respectively; while exports represent only 7 percent of the U.S. gross national product. Therefore, international trade is more important to these countries' economy than for the United States. This is not to minimize the importance of U.S. trade because it is important. However, it appears that an international common measurement system would be less important for the United States. (International trade is discussed in ch. 4.)

Further, population, land mass, and economic status affect other countries' metrication and have to be considered in reviewing their experiences. Basically, the United States has a larger population and economy than the other countries. However, we believe that these differences do not make the lessons learned invalid for the United States. The table below shows some physical and economic characteristics of these countries and the United States.

Characteristics	Australia	Canada	New Zealand	U.K.	U.S.
Population (in millions)	14	22	3.1	56	216
Area (square miles)	2,900,000	3,851,809	103,736	93,026	3,628,066
Gross National Product (in billions of U.S. dollars) (note a)	$89.5	$179.3	$11.6	$214.5	$1,594
Exports (in billions of U.S. dollars) (note a)	$11.6	$31.9	$2.2	$43.8	$106.2
Exports (as a percentage of gross national product)	13%	18%	19%	20%	7%
Imports (in billions of U.S. dollars) (note a)	$9.8	$34.3	$3.2	$53.3	$103

a/Latest available information for all countries is dated 1975.

Another difference between these countries and the United States is the type of governments. Basically, the foreign countries have a parliamentary type of government in which the executive is also the leader of the legislative branch. Two of the foreign countries only had to change national laws to effect metrication. Australia, with six State governments, and Canada, with ten Provinces, had to change some local laws. The changes appeared to be well coordinated. The United States has a Federal Government and 50 State governments. Metrication would necessitate revisions in the laws of each of these government entities. Because of the differences in government, the other countries' decisionmaking process, including changes to laws, regulations, ordinances, and codes, is less complex than the United States.

LESSONS CAN BE LEARNED FROM FOREIGN COUNTRIES' EXPERIENCES

The United States can learn from the metrication experiences of other countries. Because the United Kingdom is closer to the United States in population and gross national product than the other countries, it probably serves as a better country to study metrication. Unfortunately, some of the mistakes made in the United Kingdom may be made in the United States if the United States is to become predominantly metric.

Also because Canada has both Federal and local laws and regulations, is adjacent to the United States, and is awaiting U.S. conversion in some sectors, special consideration should be given to the lessons learned from its conversion. Therefore, in discussing the various lessons in this section of the report, we will highlight the experiences of the United Kingdom and Canada and generally discuss the other countries.

A firm Government commitment on metrication is essential

The Government's commitment to metricate must be clearly understood. If a metric conversion is the country's goal, then the Government's policy and actions must support it. This firm commitment is the principal lesson on which the other lessons are based and the four countries agreed that it is the underlying necessary principle of metrication. Basically, from our overview of foreign countries' experiences, we found that converting with minimum problems requires this firm Government commitment. It is not just a policy; it includes establishing and supporting the Government's metric board or commission, taking action when necessary to provide for conversion in private industry, establishing an overall date and specific target dates, and gaining the willingness of Government agencies to support and participate in metrication efforts.

Each foreign country's policy statement took the position that the metric system would be the predominant or sole system of weights and measures. These countries' policy statements also contained the word voluntary, like the United States. However, voluntary conversion in these countries meant that the various sectors would voluntarily agree on how and when to convert within the overall target date and goal of the country. The governments' policy statements and actions had been interpreted in Australia and New Zealand as firm commitments to convert. The United Kingdom's policy and actions were considered to be a weak commitment to convert, and Canada's falls somewhere in between.

We believe that the delays and problems that occurred in the United Kingdom's conversion can be somewhat attributed to the lack of an initial firm Government commitment. The manufacturing industry, which basically supported the conversion policy, started to convert; and education converted. But, the retail industry and the government agencies took only limited actions to convert.

However, in 1976 after 11 years of conversion activity, the United Kingdom passed the 1976 Weights and Measures Act to complete the conversion. The 1963 Weights and Measures Act, which established quantity requirements for prepackaged retail products in the United Kingdom, stated that both metric and imperial systems were legal, but contained a section--10 (10)--whereby the Government could not take any administrative actions to prevent the use of imperial units in trade. As it turned out, this section became a major roadblock to completing metrication because it stated, in effect, that the Government did not have the power to require metric units only, and this included the important retail market. Finally, the Weights and Measures Act of 1976 repealed this major legal obstacle to orderly completion of metrication in the United Kingdom.

Of equal importance to the metric program, the 1976 act authorizes the Government to set dates, after due consultation with those affected, from which time on only metric units will be used. This was to be done through Government orders which had to be approved by Parliament. There are two statutory restrictions on the use of these powers:

--The mile, foot, inch, gallon, and pint may not be made totally unlawful but the act does provide that their use, as well as the use of other imperial weights and measures in particular sectors, may be phased out.

--Cut-off dates cannot be established before April 21, 1978, for imperial packs of those goods which, when prepacked, can be made up for retail sale only in prescribed quantities.

In addition, the British Government stated that imperial units will be authorized in the retail sector where foods are weighed out in front of the customers until at least January 1, 1980.

Orders for nonpackaged goods, such as loose fruits and vegetables, hardware, textiles, and floor coverings were not approved in 1978 because of public opposition. It has been reported that the Government has abandoned further orders which are mandatory. These orders would have enabled the Government to essentially complete the conversion in the retail sector within a few years. It is uncertain what effect this decision will have on the United Kingdom's conversion program, but it indicates there is still a lack of a firm government commitment.

Other foreign countries established that the voluntary conversion meant that the country was to be predominantly metric and each converting sector of industry, Government agencies, and the general public were to arrive at a plan or specific date to convert voluntarily. In these countries firm commitments were made much earlier than in the United Kingdom. Therefore, they were able to convert in a relatively shorter time frame.

The United States has not taken a policy position on what system is to be predominant. The Metric Conversion Act of 1975 did not provide a firm national commitment to convert to the metric system. It did not stipulate whether the customary or metric system should be the predominant measurement system for use in the United States. The act and its legislative history shows the national policy as not to prefer one system over the other but to provide for either to become predominant on the basis of the voluntary actions of those affected.

A separate metric organization needs to be established

All the foreign countries established metrication boards or commissions for the primary purpose of planning and coordinating their conversions to a predominantly metric system of weights and measures, and it seems that such a body is needed. The metric organization gave each country a central focal point for metric activity. Basically, all of the boards had the power to recommend actions, but none had the power to force the conversion.

The United Kingdom announced its metric conversion in 1965 but did not establish a metrication board to plan and coordinate the conversion until 1969. From 1965 to 1969 the British Standards Institute coordinated the voluntary metric conversion in sectors of industry.

Other countries established their metric organizations early in the conversion process. One month after Australia enacted its metric legislation, the metric board had its first meeting. In New Zealand the metric board had its first meeting 10 months after the decision to convert had been made.

The Metric Conversion Act of 1975 provides for a U.S. Metric Board to coordinate the voluntary use of the metric system. When an industry, a firm within a group of industries, a Government agency, a local government, or any other entity wants to voluntarily convert, the U.S. Metric Board is to aid in planning and coordinating the conversion efforts. However, the Metric Board had not become fully operational at the time this report went to print, more than 2 years after passage of the act.

Cost of operations

Below we have presented a breakdown of metric organizations' cost for both the United Kingdom and Canada. These costs show the staff and money required for this planning and coordinating function.

In 1977 the United Kingdom's Board had a full-time staff of 48, down from a peak of 70 in 1971. The costs of the British Metrication Board since calendar year 1969 are presented in the following table.

Expenses	9 mo. ending Dec. 31, 1969	1970	1971	1972	1973	1974	1975	1976
	(U.S. dollars)							
Salaries	$129,060	$297,600	$ 397,720	$ 487,500	$ 460,660	$ 446,940	$ 630,480	$ 532,800
Administrative expenses	7,170	40,800	46,360	67,500	71,050	56,160	77,700	90,000
Accommodations and rates	121,890	180,000	195,440	205,000	203,350	208,260	295,260	325,800
Consultancy contracts	-	52,800	9,760	7,500	75,950	18,720	44,400	-
Publicity	126,670	276,000	424,560	845,000	850,150	802,620	1,110,000	1,323,000
Total	$384,790	$847,200	$1,063,840	$1,612,500	$1,661,100	$1,532,700	$2,157,840	$2,271,600

The Metric Commission Canada has 89 full-time staff members and about a $5.5 million budget for 1977-78. The costs of the Commission for 1971-72 through 1976-77 are presented in the following table.

Expenses	1971-72	1972-73	1973-74	1974-75	1975-76	1976-77
	(in U.S. dollars)					
Management	$33,428	$222,236	$ 309,941	$ 375,961	$ 151,312	$ 194,021
Research and planning	5,803	32,852	130,651	247,630	368,578	614,383
Information	284	116,357	741,447	1,439,356	1,660,708	2,764,471
Engineering industry plans	3,053	109,870	253,735	375,417	474,222	635,795
Industry and service plans	1,526	54,937	155,018	248,419	280,476	553,076
Intergovernmental	-	-	-	-	314,482	465,004
Total	$44,094	$536,252	$1,590,792	$2,686,783	$3,249,778	$5,226,750

Organizational structure

Each foreign country organized its board or commission a little differently. However, one approach was a three-tier organization--board, overall sector committees, and subsectors committees--with full-time support staff to accomplish and aid the detail planning and coordinating of various sectors of the economy. Australia, Canada, and New Zealand had this three-tier organization. Each established major committees for an industry or sector; then within these committees, the sector was broken down or divided into manageable components where the planning and coordinating took place. For example, transportation was a major committee or sector with subcommittees or subsectors for air transport, rail transport, water transport, road transport, etc. The United Kingdom's board did not have the smaller organizational levels.

In Australia the Metric Conversion Board consisted of 13 members drawn from all States with experiences in many sectors of the economy. Each advisory committee (an overall area) was chaired by a member of the board. Then sector committees (levels within the area) were established under this advisory committee. Members of all committees were nominees from appropriate organizations, national associations and institutes, and Government departments.

The following is an organizational chart of Australia's Metric Conversion Board showing this three-tier approach and committee structure.

MINISTER FOR SCIENCE

METRIC CONVERSION BOARD (Chairman: J. D. Norgard)

ADVISORY COMMITTEES

- *Education and Industrial Training* — Chairman: A.F.A. Harper
  - Sector Committees
    - Primary Education
    - Secondary Education
    - Tertiary Education (University)
    - Tertiary Education (Non-University)
    - Technical Education
    - Industrial Training
    - Adult Education
    - Cookery
- *Primary Industry* — Chairman: Sir Joseph McAvoy
  - Sector Committees
    - Grains and Seeds
    - Wool
    - Beef, Mutton and Lamb
    - Pigs
    - Poultry and Eggs
    - Tropical Fruits
    - Vegetables
    - Tobacco
    - Pome, Stone, Berry Fruits
    - Cotton
    - Sugar
    - Fishing
    - Agricultural Information
  - *Panels and Working Parties*
    - Horticultural Authorities
- *Consumer Goods and Service Industries* — Chairman: G. M. Hastie
  - Sector Committees
    - Packaging Materials
    - Packaged Goods
    - Bread and Pastry
    - Beverages and Licensed Premises
    - Textiles
    - Clothing
    - Meat Products
    - Household Utensils and Equipment
    - Financial and Commercial Activity
    - Personal Services
    - Wholesaling and Retailing (Large)
    - Wholesaling and Retailing (Other)
    - Dairy Products
  - *Panels and Working Parties*
    - Retail Scale Conversion
- *Engineering Industry* — Chairman: J. D. Norgard
  - Sector Committees
    - Mining and Metallurgy
    - Iron and Steel
    - Non-Ferrous Metals
    - Fabricated Metal Products
    - Automotive Engineering
    - Ship Building
    - Locomotive and Rolling Stock
    - Aeronautical Engineering
    - Electronics and Electrical Engineering
    - Heavy Machines
    - Machine Tools
    - Chemical Engineering
  - *Panels and Working Parties*
    - Abrasives, Grinding Wheels, Power Tools
    - Commercial and Industrial Refrigeration
    - Small Boats
    - Fastener Users
    - Metric Fasteners
    - Bicycle Descriptions
- *Building and Construction* — Chairman: A. I. Rigby
  - Sector Committees
    - Government Construction
    - Civil Engineering and Architecture
    - Building
    - Building Supply
- *Industrial Materials* — Chairman: C. R. Bunning
  - Sector Committees
    - Timber
    - Forestry
    - Paper, Pulp and Printing
    - Plastic Chemicals and Petroleum Derivatives
    - Rubber and Allied Products
    - Refractories
- *Science and Technology* — Chairman: A.F.A. Harper
  - Sector Committees
    - Research Technology Meteorological
    - Instruments
    - Liquid Measurement
    - Weights and Measures
    - Units
    - Photography
    - Petrol Pumps
  - *Panels and Working Parties*
    - Graphic Arts
    - Medical X-Ray
    - Industrial X-Ray
    - Chemicals
    - Photographic Papers
    - Typewriter Keyboards
- *Transport and Communications* — Chairman: R. H. Bartlett
  - Sector Committees
    - Road Transport
    - Railway Transport
    - Water Transport
    - Air Transport
    - Storage
    - Road Aids
  - *Panels and Working Parties*
    - Tourism
- *Land, Fuel Power and Public Services* — Chairman: J. H. Watson
  - Sector Committees
    - Petroleum Products
    - Electricity Generation and Distribution
    - Gas Production
    - Water and Sewerage
    - Land and Surveying
    - Public Administration
  - *Panels and Working Parties*
    - Real Estate
- *Health and Recreation* — Chairman: A.F.A. Harper
  - Sector Committees
    - Medical
    - Pharmaceutical
    - Recreation
    - Professional Sport
    - Amateur Sport
    - Safety
    - Youth Activities
  - *Panels and Working Parties*
    - Units for Ionising Radiation
    - Energy Value (Dietetic)
- *Public Relations* — Chairman: J. D. Norgard
  - *Panel*
    - Motion Picture and Broadcasting

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Metric organizations can provide effective planning and coordination

Each country's metric organization is responsible for coordinating and/or planning metric conversion. The Metric Commission Canada has established a detailed planning network and developed guidelines which must be followed by all of its sector committees in planning and coordinating their conversion. The Canadian planning function appears to be very detailed, and officials of the Metric Commission Canada advised us that, for the type of economic structure in Canada and the United States, they felt a detailed plan was necessary in every sector. Also, the Canadian Commission has committees to coordinate the Federal Government's departments and agencies and the Provinces' laws and agencies.

The Metric Commission Canada approached its metric conversion task as a four-phase program:

--Investigation phase. Each industry or occupation is researched to define the most appropriate metric units, metric standards, and range of metric production sizes or quantities to be used.

--Planning phase. The sequence of events and the time needed for this conversion process in each sector are determined, and these tentative estimates are coordinated with the requirement estimates of suppliers and customers.

--Scheduling phase. A timetable is developed for each industry and field of endeavor so that it can be coordinated with the other sectors within the overall target date determined by the Metric Commission.

--Implementation phase. The final stage where each sector and individual organization implements the plans laid according to the schedule. Implementation was proposed to start in 1975, increase to a peak in 1977 and 1978, and be substantially completed by 1980.

Planning, the second phase in the four-phase program, is the key to Canada's metric conversion. Each sector plan must follow a detailed network model, developed by the Metric Commission with the assistance of management consultants.

Each sector plan contains:

--A plan description with associate appendixes which describes what the sector comprises; its approach to conversion; its objectives, policy, and strategy; the

nature of any constraints or dependencies; and the present status of the program.

--An activity breakdown which identifies the main activities in the sector plan.

--An activity list and associated activity description sheets which explain the nature of the activities to be carried out, giving objectives and outlining the work involved.

--A network showing the logical relationship between the various activities required to achieve conversion and who is responsible for execution, timing, and duration.

--A bar chart derived from the network summarizing the time span covered by the major activity areas and identifying various key events in the conversion process.

In certain cases the plans' narrative may contain additional material, such as lists of standards to be converted, legislation to be amended, or products whose availability may constrain conversion of the sector.

After the sector plan is completed and after discussion with related sectors, the sector committee recommends that the steering committee concur in it. The plan is then submitted to the Metric Commission for review and approval. Once approved, the plan is published and made available to help the individual companies plan their own conversions.

If the United States is to convert, the U.S. Metric Board should consider organizing like the Metric Commission Canada. It should provide not only industry and retail coordinating committees, but also governmental coordinating committees. Even though the U.S. Metric Board was not established, certain sectors of private industry with the assistance of the American National Metric Council have begun some planning efforts which may be used to assist the Board.

<u>A voluntary conversion eventually becomes mandatory</u>

Another responsibility of the metric boards and commissions of the foreign countries was to advise the government of the need for changes to legislation or regulations to aid or complete the conversion. The U.S. Metric Board has the responsibility of advising our Government of necessary actions.

As the sectors started converting, legislation, regulations, or standards required changes. Although the changes were made to permit metric conversion, they provided an element of compulsion which made the voluntary conversion mandatory. When the various foreign governments found it necessary to amend certain laws and regulations that deal with conversion in health and safety areas, conversion became mandatory. For example, once the change of the highway signs to metric terminology was decided and the regulations and signs were changed, it became mandatory that motorists use the metric system.

The foreign countries had problems in converting the retail sector, and legislation or government regulations were required to aid this sector's conversion. Two significant changes made were to (1) require labeling the contents of prepackaged products in metric units and (2) require the sizes of prepackaged products be changed to even-rounded metric units of weights and volumes. Also, the conversion of the retail scales often required new regulations because individual retail stores did not want to convert unless all stores converted for fear that the store not converting would have a competitive advantage. Therefore, these countries established laws or regulations which stated that after a certain date only those scales which had been converted to the metric system would be legal for use.

In Canada the Metric Commission had recommended that certain laws be amended to change their measurement references to the metric system. In August 1977 the first of four planned omnibus bills was passed. The first omnibus bill amended nine Federal acts, such as Canada's Weights and Measures Act and the Consumer Packaging and Labeling Act. However, the omnibus act was neither enacted as easily nor as quickly as had been expected. Further, some metric changes that were sought concerning farm legislation were not adopted. To amend national laws necessary to ease the metric conversion in the United States may also take a considerable amount of time.

This first omnibus act gives the Canadian Government the power to prevent the use of imperial measurement units in trade and provides for the Government to (1) set a date after which a device will not be approved unless it is capable of weighing or measuring in metric units, (2) set dates after which only devices capable of weighing or measuring in metric units may be used in trade, (3) regulate the units in which commodities in retail trade can be advertised, and (4) set dates after which traditional units cannot be used in trade. Also the act removes the requirement for dual labeling on prepackaged products. A statement of net quantity in metric units will be mandatory and any other declarations will be voluntary.

In Australia and Canada there are local jurisdictions which can make changes that affect the metrication effort. Some Australian States and Canadian Provinces did not enact the laws or regulations to permit conversion at the same time. In the United States, with 50 States' laws and many local ordinances, it would seem that revisions to legislation and regulations that are necessary to ease the conversion would be difficult and a complex problem to coordinate.

The United Kindgom took action to complete its conversion with the passage of the Weights and Measures Act of 1976 which among other provisions authorized the Government to set dates, after due consultation with those affected, from which time on, only metric will be used. This was to be done by means of Government orders which had to be approved by Parliament. There were some restrictions on these powers as previously discussed in this chapter. Basically this legislation moved the United Kingdom's voluntary program into the mandatory stage in order to complete its conversion program.

Orders have been approved by Parliament fixing dates to terminate imperial quantities for a number of prepackaged foods, including sugar, salt, tea, cornflakes, biscuits, and edible fats. However, orders proposed in 1978 for nonpackaged goods, such as loose fruits and vegetables, hardware, textiles, and floor coverings were not approved because of public opposition. It has been reported that the Government has abandoned its mandatory conversion program and is reverting to its voluntary conversion program. At this time we do not know what effect this action will have on the United Kingdom's conversion program, but it is apparent that it will be some time before conversion is complete.

The voluntary conversion became mandatory in the foreign countries because an industry sector agreed to convert; national standards, regulations, or laws were revised; or local jurisdictions changed their regulations and laws. Once a group agreed to convert or regulations were revised to permit or require use of the metric system, the individual had no choice.

<u>Overall and specific target dates must be used</u>

All adopted an overall target date for substantial completion to a predominant metric system. The United Kingdom established a 10-year period for conversion from 1965 to 1975. New Zealand started in 1969 with a 1976 target date. Australia and Canada both made their decision to convert in 1970 with a target date of 1980. The larger countries established the longer conversion period.

To plan the conversion an overall target date was established. Then, as the various sectors of these countries planned for conversion, they established a specific date within the overall target date. The United States does not have an overall target, a fact that may have to change if it is to be a predominantly metric country. An overall target date should be established when a firm commitment to convert is established. Then the sectors should establish specific dates within the overall target. The United States, because of its characteristics, may need a longer conversion period to become predominantly metric than these other countries. Our review showed that the optimum period for 80 percent of the firms we contacted was 15 years.

General public education and the retail trade sector should not be neglected

Educating the general public is essential for a successful conversion to a predominantly metric system of weights and measures. Converting the retail sector seemed to be the biggest problem in metrication.

In Australia, Canada, and New Zealand, efforts were made from the start to keep the general public informed. Each country seemed to have a little different approach, but they moved the retail conversion along with the industry conversion. In the United Kingdom where the retail sector was left for last, the consumer opposition seemed to slow down the conversion efforts.

The Australian board published metric handbooks for various sectors of the economy to alert these sectors to changes affecting them. The information most widely disseminated was a booklet entitled "Metric Conversion and You," which was mailed to every household in Australia. In creating metric awareness, the board believed it was necessary to have the continuing cooperation of the media. From the outset, it sought to ensure uniformity in correct metric usage and favorable media relations by providing guidelines to reporters and to news and sports commentators.

The Australian Prices Justification Tribunal, which checks proposed price increases sought by larger industrial and service enterprises, has reported that metric conversion has not been a significant factor in cost increases and inflation. A comparatively small number of specific complaints of consumer "rip-offs" have been reported to the Metric Conversion Board and consumer protection authorities. With the exception of one case of a builder unjustifiably attributing

the increased cost of a building contract to metric conversion, the unfair practices reported and investigated were mainly the result of human error rather than deliberate attempts to take unfair advantage during the conversion.

New Zealand's Metric Advisory Board made metric information readily available to the general public. At every post office, "Metric Memos"--a series of 11 pamphlets containing general information about metric units and its uses--were available. A booklet, "At Home with Metrics," was mailed to every household. Metric information was published and distributed to those concerned, and the Board had set up an Information and Distribution Bureau for handling all requests for information. The emphasis was on a gradual metric awareness and a basic facility in using the metric system. New Zealand's Metric Advisory Board felt that its publicity program was a significant factor in accomplishing the conversion.

Metric Commission Canada published a consumer guide, provided other literature, and advertised the conversion. It instituted a practice to review metric products and material when requested as a means to assure uniformity in usage of metric symbols and terms. If the material or product has correct metric usage, then the Commission's logo, "a stylized maple leaf and an M," is allowed to be placed on the product or the material. It is not an endorsement of the item but rather allows the consumer to identify products having correct metric usage or terminology. Only that material reviewed by or under the Metric Commission Canada could use the logo.

While the retailers are not in the "vanguard" of conversion, most Canadian retailers have cooperated with the retail sectors' overall conversion plan. This cooperation was coupled with a determination to achieve metric conversion at the lowest possible cost to customers and themselves. The introduction of metric sizes at the retail level was determined by their suppliers and took into account existing stocks of imperial sizes, the availability of product packages or containers, and timing with other suppliers' introduction of competing products.

Canada's conversion of consumer products had generally gone along rather smoothly, but there have been a few instances where problems have occurred. For example, consumers raised questions when some retailers sold 2 kilograms (4.5 pounds) of sugar at the same price that 5 pounds had previously been sold. A problem also arose when the conversion of ice cream containers was accompanied by an increase in price because the metric sizes were smaller than the comparable imperial sizes. The price increases, however, were found to be attributable to pricing errors in some cases due to the

similarity in sizes or to overall raw material cost increases that were occurring in the dairy industry, not to the cost of converting to metric size products. The problems that occurred early in the conversion have led to the adoption of guidelines by the food industry.

In September 1976 nine Canadian associations representing the food industry endorsed a series of guidelines that will govern marketing procedures during the food industry's conversion. These guidelines are intended to ease consumer concern over possible price increases as a result of metric conversion and state, in effect, that the Canadian food industry intends to do everything possible to make the transition as equitable as possible for the Canadian consumer. The four general guidelines are:

--It is preferable to round up to a larger metric size than to round down.

--Where there is a change in product size leading to a change in product cost, a change in unit price should reflect not more than the cost of conversion.

--Other costs, separate and distinct from adjustments based on product size conversion, will continue to be handled as in normal business practice.

--Information to assist the consumer in recognizing and understanding conversion to different metric product sizes will be provided by the industry as appropriate.

In the United Kingdom government officials, as well as, industrial, retail, and consumer organizations wanted to limit the use of a dual system to as short a time period as possible. This highlighted the need for statutory cut-off dates which the 1976 Weights and Measures Act permits as discussed previously. The British Government also promised, during passage of this 1976 legislation, that it would apply adequate consumer safeguards about prices and see that adequate information was given during the changeover period.

Since the 1976 act, the process of phasing out by law the use of imperial units in sectors of trade has begun. Orders have been approved by Parliament fixing dates to terminate imperial quantities for a number of prepackaged foods, including sugar, salt, tea, cornflakes, biscuits, and edible fats. However, orders for nonpackaged goods, such as loose fruits and vegetables, meats, hardwares, textiles, and floor coverings were not approved in early 1978. It has been reported that the British Government has abandoned its mandatory conversion program and is reverting to its voluntary conversion program. Thus, the retail sector in the United Kingdom is in a very

confused state. Some items are sold in mandatory metric units, and other items are remaining in imperial units.

The British Government has acknowledged that consumers fear metrication may be used as an excuse for unjustified price increases. The Department of Prices and Consumer Protection's price control system exists to prevent unwarranted price increases and has a standing order to keep under continuous review the effect of metrication on retail prices. Its first report, in April 1977, dealt with 12 separate branded items of granulated sugar, biscuits, dried peas, and salt. In six cases the metric pack was better value for money than the imperial pack which it has replaced; in two there was no appreciable change in value; and in the remaining four cases the unit price had increased slightly, but wholly for reasons other than metrication.

A change where metrication has frequently been blamed for price increases was that of knitting yarn. The 1-ounce ball was changed to 25 grams (1 ounce = 28.35 grams). This reduction in size--about 12 percent--carried no corresponding reduction in price, but this was because the world price of wool had increased dramatically in 1972-73.

The Metrication Board's experience is that, if information is properly planned and timed, the change to metric presents no major problems to consumers. The Board's view is that retailers are not looking for an opportunity to make concealed price rises. They want to stay in business and have to operate in a highly competitive market.

Also the British Government believes that metric information should be made available at the point and time of purchase. The 1976 act provided the Metrication Board with powers to enforce the display of certain information. It is the Metrication Board's primary responsibility to see that the consumers and general public are informed and advised about the timing of any metric changes affecting them and about the few common metric weights and measures which they need to know. In carrying out this responsibility the Board seeks and receives the cooperation of press, broadcasting, and trade and industrial organizations.

A particularly successful change was for cornflakes. Metric boxes were first introduced by the major producer in November 1975. The development was supported by public relations material prepared and issued jointly by the company and the Metrication Board, including a national advertising campaign and point-of-sale information. As it happens, prescribed quantities in the United Kingdom for metric prepackaged products are generally about 10 percent larger than the

imperial quantities they replace. Thus metrication involved an increase in the quantity of cereal in each size. The major producer conducted interviews with housewives and consumer groups and decided to convert voluntarily, provided consumers could be shown that there was no price increase per serving.

The plan was to retain the same size boxes so that no extra costs would be incurred in producing new ones; by shaking the box while filling it, the company found that it could add the additional 10-percent contents. This was explained to the consumer by the company on the box and by the Metrication Board in the press.

The cornflake conversion was completed by mid-1976. In the end consumers paid only 5 percent more for 10 percent more quantity. Since then sugar and flour have gone metric. Metric information was printed on the packs of each and supported by advertising and consumer personal aids. These changes have been accepted without adverse comment from any consumer organizations, and there were very few individual complaints.

It appears, on the basis of the experiences of the foreign countries, that if the United States wants to be predominantly metric, the problem of general public education and the major task of converting the retail trade sector should not be neglected.

Government financial assistance

All countries initially adopted the policy of having costs lie where they fall, but some countries revised or supplemented it to various degrees in providing some government financial assistance or incentives.

Australia adopted the policy that compensation for conversion costs would not be provided. However, these tax concessions were granted which have softened the impact of conversion:

--Accelerated write off of capital costs incurred as a result of conversion.

--Waived sales tax on metric conversion kits required to convert equipment used for business purposes.

--Waived import duty of conversion kit.

Also, the Australian Government has provided a total of $18 million (Australian) to the State governments to aid the conversion. Most of the State's revenues come from the Federal Government.

The Canadian approach to metric conversion was voluntary, and each firm and organization was to be guided by its evaluation of its own short- and long-term interests. Each firm was expected to identify the opportunities for change and to bear its own costs. This is the same philosophy adopted by other countries of letting costs lie where they fall. However, financial assistance has been established to defray the conversion costs in certain areas.

The Canadian Cabinet approved in March 1977 a $40 million (Canadian), 5-year assistance program for workers who must purchase their own tools for employment. This new assistance program reimburses eligible employees with 50 percent of the amount spent on purchasing new metric measurement-sensitive tools. It does not apply to self-employed persons nor to persons who are provided tools by their employers. The program became effective on April 1, 1977, and is scheduled to terminate on March 31, 1982.

The program is in response to a request made by organized labor and industry. It will not only assist employees but also businesses that usually require employees to provide their own tools.

A special unit was established within the Metric Commission to administer this program. The Commission will check claims to insure (1) purchase slips or receipts are submitted, (2) claims are certified and verified by employers, and (3) tools purchased are measurement sensitive. The Commission estimated that a minimum requirement of 15 staff-years would be needed to process the estimated 100,000 claims each year.

Income tax assistance is being provided to the self-employed and companies for tools, scales, and other equipment which require changes because of metrication. The tax code revision permits the equipment conversion cost to be treated as a deductible expense, rather than as a capital expenditure, even though there is an improvement in the capacity or quality of the equipment. However, if the conversion cost exceeds the metric unit replacement cost, the equipment cost is then considered a capital expenditure and is not deductible as a current expense.

Further assistance is being provided for the conversion of scales. Legislative amendments enacted in June 1977 revised the Federal sales taxes and import duty on metric scales and kits to convert to metric. The normal Federal sales tax rate is 12 percent. The Federal sales tax on conversion kits will be exempted; and for new scales, the Federal sales tax will be half of this 12-percent rate. The import duty on scales and kits, which is normally 17.5 percent, will also be

exempted. The relief on the scales was to aid in the conversion of the consumer area.

The Canadian Federal Business Development Bank, which provides financial assistance and management services to all businesses, is to provide small businesses with metric conversion assistance. The plan provides that small businesses with annual gross revenue not exceeding $1,500,000 (Canadian) can qualify for financial assistance for metric conversion.

New Zealand adopted the policy of letting costs lie where they fall and did not provide any financial assistance or tax or tariff relief to aid any sector's conversion. The United Kingdom adopted a policy of letting costs lie where they fall when converting to the metric system and believes that the policy of refusing financial assistance can be maintained.

It appears that the financial assistance provided by some foreign governments seemed to make conversion more palatable, particularly with respect to the conversion of retail scales. The United States has only provided for financial assistance in the area of education where $6.3 million has been appropriated.

<u>Government purchasing power to assist the conversion</u>

Government agencies in these countries participated in each sector plan and provided support for the planned actions and time frames established by the sector by using the government purchasing power. However, the United Kingdom, early in metric conversion, did not permit its government agencies to aid conversion by asking for and buying metric products. In Canada the government announced that if a metrication plan was established for a particular sector, like the building and construction industry, Canada would require that all government contracts would use the metric system after a date specified in the plan. This was particularly helpful in solving the problem of producers not making an item until it was requested, and nobody requesting an item until it was produced. Other foreign government agencies also aided in the metric conversion by using their purchasing power.

In the United States the Metric Conversion Act provides for the U.S. Metric Board to study the use of Government purchasing power.

<u>Other lessons</u>

Other lessons or experiences of the foreign countries are:

--The use of sports and weather forecasts were an excellent way to aid the general public's education of the metric system.

--Periods of dual labeling should be kept to the minimum necessary to enable the public to become familiar with new metric sizes.

--Hard conversions, rather than soft conversions, of products should be made whenever practicable to obtain benefits.

CONCLUSIONS

The United States as a Nation has a larger population, economy, and Government than the other foreign countries. However, it can learn from other foreign nations' experiences, generally and in each particular sector if it is to be predominantly metric.

Generally, the lessons learned and the current position in the United States is as follows:

--A clear and firm Government commitment to convert is necessary to achieve a successful conversion. The United States has not adopted this policy, and there is much confusion as to whether the United States is committed to a metric America.

--A central body should be established early, shortly after a national commitment is made, to plan and coordinate the conversion and inform the various sectors and the public of metric activity. The U.S. Metric Board had not become fully operational--over 2 years after the passage of the act--at the time this report went to print.

--A well-developed plan must be prepared and effectively implemented. There is no national plan and should not be under the current law and policy. However, there is some coordination being done by the American National Metric Council, though most of it is very preliminary.

--A successful voluntary conversion must eventually become mandatory through laws and regulations, etc., in order that the metrication program can be completed. Necessary exceptions should be permitted. The act did not contain and the U.S. Metric Board does not have any compulsory powers.

--An overall target date must be established for the country by the government and specific target dates must be established for the various sectors by those affected. The United States does not have an overall target date for conversion.

--The public must be adequately informed and educated, and responses must be made to consumer concerns. Conversion of the retail sector is the most difficult and must receive special attention. These are some of the responsibilities of the U.S. Metric Board.

--The principle of letting costs lie where they fall should be adopted if at all possible. All the foreign countries did this, although a few made some exceptions. The 1975 Act does not provide for financial assistance programs.

--The use of the government's purchasing power greatly facilitates the conversion. (Government should be careful that it does not pick up the tab for an inordinate amount of private enterprise's metrication costs.) Using procurement by the Federal Government as a means to effect conversion is one of the subjects mentioned in the 1975 Act that the U.S. Metric Board may examine.

--The conversion of certain sectors, such as weather reporting and sports is an excellent means of educating the public. The National Weather Service has a plan to do just this regardless of the current national policy. Some sports, notably field and track and swimming, are using the metric system because world records are in the metric system, and [illegible] essentially in the Olympics. Under the current U.S. national policy, it would seem inappropriate to convert weather reporting and sports for educational purposes.

--Avoid dual labeling whenever possible and keep the time period of dual usage to a minimum. The U.S. Metric Board could encourage the adoption of this policy by those that decide to voluntarily convert, but it would be more appropriate under a national program with a firm Government commitment.

--To assist firms and other organizations in the preparation of materials and products used for distribution or sold to the public, the Metric Commission Canada established the capability to review proposed

material for accuracy of metric terminology and permitted the use of its logo on approved material. This assures the public that the metric terminology is accurate. It was not an endorsement of the product. Consideration should be given to establishing a similar procedure in the United States."

We believe, on the basis of the conversion lessons learned from the foreign countries' experience, that if the United States is to be predominantly metric, the Congress should amend the Metric Conversion Act of 1975 to make it the national policy to convert to the metric system as the predominant system of weights and measures within a certain number of years. Also, the U.S. Metric Board should accept the lessons learned by the other countries.

CHAPTER 31

METRICATION SUMMARY

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The United States is moving toward adopting the metric system of measurement without a clear understanding of what is involved in metrication and whether the ascribed benefits can be realistically achieved. The issue of whether the United States should adopt the metric system has not been resolved. The public is not yet fully aware of the personal impact on them, and the business community in general, especially small businesses, does not realize the full impact on their operations.

The terms meter, liter, and gram are appearing, sometimes alone but often with their "cousins," the foot, quart, and ounce. The latter terms are the most familiar to Americans and are part of what is commonly referred to as the customary system of weights and measures. Meter, liter, and gram are part of the metric system. When you hear or see temperature in degrees Celsius, it is also part of the metric system. Use of the metric system is increasing, but the customary system is by far the most predominant in the United States.

Almost since its inception, the United States has considered adopting the metric system in one form or another as the national measurement system. Its use was officially authorized over 100 years ago. There have been several major movements to replace the customary system with the metric system, but all such attempts have failed. However, the latest effort which began more than 20 years ago, is beginning to have some impact.

Persons who use the metric system seem to like it and have few problems with it. But metrication is much more than simply learning and using the metric system. Metrication includes determining the best time to convert in order to minimize costs; agreeing on metric sizes; designing, producing, and building in metric dimensions; training personnel in metric; obtaining metric supplies; changing laws, regulations, ordinances and codes to accommodate the metric system; informing customers about metric products; and remaining competitive in the marketplace.

There are actually two types of conversion, hard and soft. Soft conversion means replacing customary measurement units with equivalent metric units without any changes in the size of products, materials, or structures. One quart, for instance, becomes 0.95 liters. Hard conversion means a change in the actual dimensions of products, materials, or

structures to metric dimensions--1 quart is replaced by 1 liter which is 1.06 quarts. Generally, hard conversion results in rounded metric numbers which are easier to work with.

Converting to the metric system would eventually mean thinking, hearing, and seeing distances in terms of meters, volume in terms of liters, weights in terms of grams, and temperatures in Celsius. It would mean new sizes for screws and bolts, new distances on maps, new weights on scales, new speed limits on highways, and new tools to repair automobiles and other products. It would also mean new sizes for beverages, food, and clothing; new recipes in the kitchen; and revisions in educational materials. Of course, it does not mean that all sizes, distances, and weights actually would change, although a great many would; but the terminology and numbers used to express them would. Metrication would probably be a combination of soft and hard conversion. The change would not necessarily be sudden and complete.

A change to the metric system would be significant. Metrication would affect Americans at work, in school, at home, in shopping, and in their leisure activities. Every organization, firm, industry, and level of government would feel its impact. The impact could surprise many Americans.

If conversion is to take place, Americans must be kept fully informed of what is taking place, why the changes are being made, who benefits, who pays, and how it will affect them. We have looked into the subject of metrication to provide the Congress, the Administration, the Metric Board, and in turn all Americans with a better understanding of these and the other issues involved.

THE METRIC DEBATE

The issues basically center around the advantages and disadvantages and the costs and benefits. Which outweighs the other? The debate has been going on almost since the Nation's birth. The answers are complex and in most cases undeterminable. It is very difficult to determine the answers for a single firm, let alone an industry. To answer the question for a Nation with 218 million people with the largest economy in the world, is even more difficult, particularly when pertinent data is unavailable. The following are the generally ascribed advantages and disadvantages.

Ascribed advantages

The ascribed advantages frequently attributed to metric conversion generally relate to one or more of the following.

--The metric system is a better measurement system.

--The United States would join the rest of the world in a common measurement language.

--Conversion would help improve or maintain the U.S. foreign trade position.

--The process of converting would provide opportunities for worthwhile changes.

--Conversion would stimulate the economy.

--Conversion is inevitable and would cost more later.

Ascribed disadvantages

The ascribed disadvantages frequently attributed to metric conversion generally relate to one or more of the following.

--The customary system is a better measurement system.

--Conversion would be enormously expensive.

--Conversion would cause confusion.

--Conversion would hurt the U.S. economy.

--There is no need to convert to the metric system.

NATIONAL BUREAU OF STANDARDS METRIC STUDY

After 10 years of similar bills being considered in the Congress, the Metric Study Act (Public Law 90-472) became law in August 1968. The act called upon the Secretary of Commerce to

--determine the impact on the United States of the increasing use of the metric system;

--consider the desirability and practicability of increasing its use in the United States;

--study the feasibility of retaining and promoting engineering standards on the basis of the customary system;

--examine the effects on international trade, foreign relations, national security, and also the practical difficulties of greater use of the metric system; and

--evaluate the costs and benefits of alternative courses of action that the United States might take.

As the NBS metric study progressed, the study group concluded that the United States is already increasing its use of the metric system and that sooner or later the United States will probably become predominantly metric. Thus, the study's major thrust changed from whether the United States should convert to the metric system to how--planned or unplanned.

In July 1971 the Secretary of Commerce issued his report, "A METRIC AMERICA, A Decision Whose Time Has Come." The report stated that eventually the United States will join the rest of the world in using the metric system as the predominant common language of measurement. The basis for this conclusion was that the United States is already metric in some respects, that it is becoming more so, and that the great majority of businessmen, educators, and other informed participants in the study reported that the increased use of the metric system is in the best interest of the Nation. The specific recommendations in the report were:

--The United States should change to the international metric system deliberately and carefully through a coordinated national program.

--The Congress should establish a central coordinating body to guide the change.

--Detailed conversion plans and timetables should be worked out by the sectors themselves within this framework.

--Early priority should be given to educating school-children and the public at large to think in metric terms.

--Immediate steps should be taken by the Congress to foster U.S. participation in international standards activities.

--Any conversion costs should "lie where they fall."

--The Congress should establish a 10-year time frame for the United States to become predominantly metric.

--There should be a firm government commitment to convert.

The report's recommendations did not settle the metric question. Bills to implement the recommendations were debated

in the Congress for the next several years; none were passed. Although the advantages and disadvantages of metric conversion for the United States were still an issue, a major area of controversy was the impartiality and completeness of the NBS metric study. The critics, which included former members of the study group and its advisory panel, contended that NBS was biased in favor of conversion while performing the study and reporting the results. The critics did not believe that the study adequately addressed the costs and benefits of converting.

WHAT IS THE NATIONAL POLICY?

Many people and organizations believe a decision has already been made to adopt the metric system in the United States. Passage of the Metric Conversion Act of 1975, with its major provision of establishing a U.S. Metric Board, is cited by many as being the official national commitment. Just the name of the act connotes conversion. The number of firms converting is pointed to as evidence of the trend toward the metric system, although our work showed this activity appears not to be as significant as is generally believed. Despite opinions and statements to the contrary, it is not the United States' policy to convert to the metric system.

Metric conversion legislation was passed in the Senate in 1972 providing for a predominantly metric America within a 10-year period. But when introduced in the House, no action was taken. In the following years, various unsuccessful legislative proposals were discussed. Further progress was not made until 1975 when the provisions for a predominantly metric America within 10 years was dropped.

On December 23, 1975, the Metric Conversion Act of 1975 was enacted declaring that

> "* * * the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

The act does not provide a national commitment to convert to the metric system. It does not stipulate whether the customary or metric system should be the predominant measurement system for use in the United States. The act and its legislative history show the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected. Thus, a national decision has not been made to convert to the metric system.

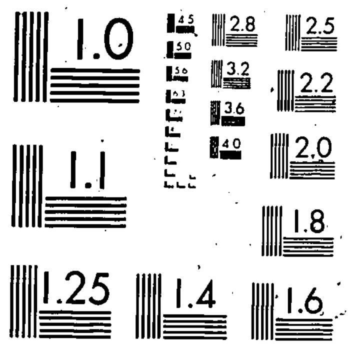
The Metric Board's responsibility under the act is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert. At the time this report went to print, the Board had not become fully operational. All 17 members of the Board were nominated by the President and were confirmed by the Senate during the first half of 1978. Several Board meetings have been held.

The national policy is not generally understood. About 80 percent of small businesses and the general public we contacted either did not know what the national policy is or think conversion is mandatory. However, about 70 percent of the largest businesses did know that the national policy is one of voluntary conversion. There have been numerous misstatements made throughout the country not only about the policy but about the various aspects of metrication itself. Actions by a number of individuals and organizations, including some multinational firms and agencies of the Federal Government, give the impression of a national commitment to a metric America. The metric system is being taught in at least half the Nation's school districts. When parents learn about the additional emphasis on teaching their children the metric system in school, a natural tendency is to believe that the Nation is converting.

IS CONVERSION VOLUNTARY OR MANDATORY?

Under the present national policy, conversion to the metric system is to be "voluntary"--those involved can decide for themselves whether or not to convert. In other countries that are converting, "voluntary" means that the various sectors voluntarily agree on how and when to convert within the overall parameters of a national commitment to convert to the predominant or sole use of the metric system during a specific period of time, usually within 10 years or less. In other countries voluntary was not a choice of whether to convert or not, as it is in the United States.

In the absence of a national policy favoring either system, it is extremely important who makes the voluntary decision for each sector. Realistically, however, voluntary does not mean that each person can make an individual determination. Generally the large and influential organizations, both public and private, are making or are helping to make the decisions. A manufacturer may decide to convert and this



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

voluntary decision may result in forced or mandatory conversions by others, such as customers and suppliers. A customer may choose to buy or not buy a metric product, but only if aware that the product is metric and that a competitive non-metric product is available.

The voluntary aspect is particularly important when a Federal, State, or local government agency voluntarily takes or proposes metric conversion actions which change the measurement system used by large portions of the general public. Thus, a voluntary decision by government, in effect, becomes mandatory on the general public. For instance, the highway sign conversion plan proposed in 1977 showed that the Federal Highway Administration "voluntarily" decided that all road signs would be metric. Such a decision, however, would make it "mandatory" on States, localities, motorists, and others. After receiving national attention, the plan was rescinded basically because of congressional and public outcry. It is questionable whether the Federal Highway Administration has the authority to require such a sweeping change which would cost millions of dollars and result in no apparent benefits.

The decisions by some giant multinational firms to convert have an impact or ripple effect on their suppliers because of the multinationals' orders for metric items, products, or supplies. The suppliers, unless they can forego continued business with these firms, will have to produce metric products and may eventually convert their entire operations to metric. This is happening today in the automobile industry where the suppliers are filling metric orders from the automobile manufacturers. Whether the suppliers will completely convert their operations will only be known over a period of time, but it is certain that at least some of their operations will be converted. It must be kept in mind that of those giant multinationals that decided to convert, most made their decision when it appeared that national legislation would be passed providing for a predominantly metric America within 10 years.

Many think conversion is mandatory, especially small businesses and the general public. Responses to our questionnaires showed that 42 percent of the small businesses and 23 percent of the people contacted in a public opinion poll conducted for us believed conversion to the metric system is mandatory. In fact, less than 20 percent know what the national policy is.

Actions by Federal agencies, multinational firms, educators, and others aided by a general feeling of inevitability and misstatements about metrication throughout the country tend to forge a metric policy for the entire Nation. A

policy to convert to the metric system should be made by the representatives of the people--the Congress. It appears to us that under the present policy and the current trend of events, the United States will eventually become a predominantly metric country.

Current policy has been misinterpreted and within this context attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sectors, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

THE INEVITABILITY SYNDROME

A majority of the large and small businesses and building and construction associations responding to our questionnaires believe conversion to the metric system is inevitable for their industries. Also, a majority of State governments believe metrication is inevitable for themselves. These beliefs, as much as any perceived benefit, have been a principal impetus for conversion activity in the United States. Conversion may well become inevitable because people think it's inevitable--a self-fulfilling prophecy.

Several factors and beliefs have contributed to this inevitability syndrome:

--Passage of the Metric Conversion Act of 1975 and its major provision for a U.S. Metric Board. Just the name of the act connotes conversion.

--The United States is the only major nation not converted or committed to using the metric system.

--Actions taken by some Federal agencies, such as the Federal Highway Administration which attempted to require conversion of highway signs; the National Weather Service plan to use the metric system for weather

reporting; and the suggestion by the Department of Agriculture to convert meat and poultry labels.

--The decision to convert by some of the "giants" of industry and the effect on customers and suppliers.

--The 1971 NBS report which stated that there was no question that the United States should convert within a 10-year period.

--Proposed legislation in the early 1970s which called for a predominantly metric America within 10 years.

--Publicity about metric projects and activities and the distribution of metric information and charts.

--The increase in metric instruction in school programs throughout the country with many setting target dates--1980 for 13 States--when their school systems are to be teaching the metric system as the predominant system.

--Federal grants for metric education.

--Activities of the American National Metric Council established in 1973 by the American National Standards Institute to coordinate metrication for industry.

Action should be taken to ensure that metrication does not occur merely because it is thought to be inevitable, which is apparently what is taking place today. The national policy, as established by the Congress, is that conversion is voluntary. Businesses or other entities generally should convert if it is in their best interests to do so or they may continue to use the customary system, and should not embark upon a course of conversion merely for the sake of conversion.

SUPPORT/OPPOSITION AND OVERALL ADVANTAGES/DISADVANTAGES

Responses to our questionnaires showed that the strongest support for converting to the metric system came from State education officials, State government officials, and the Fortune 500 industrial companies. Building and construction associations supported conversion but not as widely as the above groups. Small businesses were divided with slightly more being opposed to metrication than supporting it. The public opinion poll showed most people in opposition to metrication.

The respondents' support for conversion is not based entirely on the belief that they will gain some advantage from converting. More supported conversion than saw advantages for themselves. In fact, large businesses were divided on whether advantages outweigh disadvantages for their firms (slightly more saw it as an advantage). The reaction of small businesses was more pronounced in that more believed the disadvantages outweighed the advantages for their firms.

However, when asked about the advantages and disadvantages for the United States overall, both groups significantly shifted to a more positive opinion on advantages. A majority of the large businesses believed the advantages to be greater than the disadvantages, and more of the small business respondents believed conversion would be advantageous than disadvantageous.

Thus the question arises as to just who benefits to make it worthwhile for the United States as a Nation to convert to the metric system.

GOVERNMENT

No overall metrication policy or plan has been developed to guide Federal agencies. Many agencies have or are developing a policy and a number have or are developing specific plans to go metric. Generally, the agencies have a policy of following industry's lead and coordinating their efforts. However, some agencies, such as the Federal Highway Administration, the National Weather Service, and the Department of Agriculture have been proceeding on their own and appear to be propelling metrication. Such actions give rise to impressions that the Federal Government is mandating conversion as 23 percent of the persons interviewed in a public opinion poll conducted for us, and 42 percent of the small businesses responding to our questionnaires, believe.

The overall metrication activities of Federal agencies need direction and coordination to ensure that the Government takes a consistent approach to metrication and that Federal agencies do not force conversion activities to occur, contrary to the intent of the Metric Conversion Act of 1975.

Other countries with a Government commitment to convert used Government purchasing power to aid the conversion process. This is particularly true in what we identified as a "chicken and egg syndrome" that occurs when manufacturers are willing to produce in metric, once their customers order in metric and customers are willing to buy in metric once the manufacturers are producing in metric. Government

purchasing powers could be used to breach this log jam by ordering in metric on a sector by sector basis once a commitment to convert is made as was done in Canada.

There has been some discussion of the use of the metric system as a means to achieve standardization in NATO. The problems of standardization within NATO are the result of a multiplicity of research, development, and production problems of the member countries. It is generally acknowledged that political, economic, and social conditions often take priority over standardization efforts. However, standardization of NATO's weapons is a very important objective. Nonmilitary factors, such as inflation, unemployment, balance of payments, and the maintenance of a strong industrial capability must be considered. Thus, in our opinion, even if the world was metric today, NATO would still have its standardization problems.

U.S. Metric Board

All 17 members of the Board were nominated by the President and were confirmed by the Senate during the first half of 1978. Although the Board has met, it had not really become fully operational at the time this report went to print.

The duties of the Metric Board put it in the position of a central planner and coordinator. The Board should not place itself in a position where it is perceived to be an advocate or opponent of metrication. The intent of the Metric Conversion Act of 1975 is that the Board is to be neutral.

The consensus of respondents to our questionnaires was that the principal role of the Federal Government would be to counsel and advise interested parties on metrication and coordinate metrication activities. More respondents believed that target dates should be established by the U.S. Metric Board in consultation with industry than by any other group. That is, the respondents believed they should have a say in the target dates.

We agree that specific target dates for each sector that voluntarily decides to convert are needed. All affected parties including consumers, should be involved in making the basic decision to convert or not. They also should be involved in developing a plan and setting target dates. The decision that a sector has voluntarily decided to convert along with the rationale should be made public. Public hearings which are authorized under the Metric Conversion Act of 1975 should be held for those conversion plans that affect the general public.

Conversions have occurred without a Metric Board. For example, even before the NBS study, the pharmaceutical industry basically converted to the metric system in some of its internal operations. The automobile industry is proceeding with metric conversion without the involvement of the U.S. Metric Board. The wine and distilled spirits industry likewise has planned and coordinated its conversion without the Metric Board.

Some aspects of these conversions have not benefited everyone as much as possible, but without compulsory powers the Metric Board might not have been able to solve these problems. The Board was not provided any such powers.

States

State governments generally adopted a wait-and-see attitude about converting, although many support conversion. In discussions with State officials, we found little agreement, even among departments within States, about when, where, and how conversion should take place within State governments.

Most States believe that their metrication efforts would be facilitated if the U.S. Government would establish target dates for voluntary conversion, provide financial and technical assistance to States, change all Federal laws that specify use of the customary system, and develop a national metrication plan. Slightly more than 50 percent of the States also believe that making conversion mandatory with established deadlines would help States convert.

We identified five States which had passed legislation promoting metrication. A few others have proposed metric legislation but it had not been passed. Most of the States, however, had not seen fit to introduce or amend laws to support conversion.

Metric conversion is seen by many State governments as a noncrisis-oriented, expensive activity with very few near-term benefits. They also question the wisdom of proceeding into conversion out of phase with other States, thereby creating a confusing and possibly dangerous environment for interstate travelers and those engaged in interstate commerce. States fear becoming a "metric island" among other nonmetric neighboring States.

Any Federal metric activity should be coordinated with the States.

Education

The Office of Education, Department of Health, Education, and Welfare, has been involved in metric education since 1972. Programs funded by the Office of Education have been designed to develop metric education instructional materials in vocational, technical, and adult education and teacher training materials for people with sight handicaps, reading difficulties, and other learning deficiencies.

Other funded programs were directed toward developing working models which States and territories could use in the transition to metric education and planning how the Nation's educational institutions can best prepare Americans to understand and use metrics. Those programs were supported by the Office of Education through funds not specifically appropriated for metric education--elementary, technical, adult, and research funds. Legislation passed in August 1974, however, specifically provided for metric education grants in fiscal years 1976, 1977, and 1978. A total of $6.3 million was appropriated for this grant program. It appears that before additional funds for metric education are considered, the education effort should be examined and put into phase with whatever metrication plans and efforts exist in industry, Government, recreation, merchandising, and other sectors.

Educators stated that the metric system is easier to learn and teach and results in fewer errors. It has been stated that teachers would have more time for other educational efforts because metrics can be learned more quickly, but we did not find a consensus on this.

In the schools the trend is toward metrics as children are being taught the metric system throughout the Nation. All State education agencies supported metrication. In fact, 13 States had set 1980 as the target year for the school systems in those States to be teaching predominantly in the metric system. However, this trend may be harmful because such dates had not been coordinated with any other conversion activity in our economy or society or with an anticipated need. Thus, there may be a generation of children who were primarily educated in metric trying to function in the customary system in the United States.

The question therefore arises as to how much each school system should teach and when. It is obvious that some metric education is advisable. State education agencies' views differed on how long a period of dual measurement capability would be needed by students. Depending on the long-range metrication timetable of some industries and the possibility

that some segments of the economy would not convert at all under a voluntary policy, it is likely that the customary system would need to be taught along with the metric system. What is used predominantly in the community should be the predominant system taught in the schools. Our educational system needs guidance on the national policy and its implementation.

Legal implications

Metrication would require reviewing laws, regulations, ordinances, and codes at all levels of Government to see whether there are measurement-sensitive provisions that would need to be changed. This would be an enormous undertaking. Under the present national policy where there is no commitment to convert, it would be even more difficult.

It could be viewed as an opportunity to make improvements and eliminate those laws, regulations, ordinances, and codes which are obsolete or unneeded, but metrication is not necessary to make such changes. The process would entail the expenditure of a considerable amount of time and money, and much confusion would result if some legal provisions were converted and others were not.

Various officials in the private sector have been concerned that jointly planned metrication activities could subject participants to law suits under the Sherman Anti-Trust Act. The Department of Justice has provided guidance on steps industries can follow when carrying out their metrication activities.

BENEFITS

Ascribed benefits of metrication are not as closely related to metrication as they are claimed to be. Most are goals which have previously existed and have been achieved to varying degrees under the current system. Proponents view metrication as the vehicle to achieve them (to a greater degree). It is doubtful that many of these benefits would be achieved through metrication without incurring costs which would partially or wholly offset or even exceed the value of the benefits. Also, certain benefits, such as increased standardization and rationalization of consumer products, might be unattainable without the imposition of Government laws and regulations.

The often ascribed benefit that the metric system is easier to use and results in fewer errors is generally but not universally accepted. There was some disagreement from small businesses. The value of such a benefit cannot be

determined, but it may be one of the few direct benefits of metrication.

Both the proponents and opponents have expressed concern over the effect conversion would have on U.S. trade and relations with foreign countries. However, the effects of metrication are not as clear cut as either the proponents or opponents contend. We could not determine from available sources the extent to which U.S. trade will be affected, either in the short or long term, by a decision to become predominantly metric or to remain predominantly customary. The effects of metrication in promoting or deterring trade are presently considered by the firms we contacted to be relatively insignificant, and companies in the forefront of metrication appear to be pursuing conversion for reasons other than a possible favorable impact on trade.

A majority of large businesses believed conversion would facilitate trade because a common measurement language would come into use. Trade is also facilitated where the same language is used. But an even larger majority indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms cited factors, such as competitive prices, high product quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. The design and manufacture of products and engineering standards in either metric or customary units were not considered to be a significant trade factor.

Some view metrication as an opportunity to improve production efficiencies, facilitate technological advances, and make other worthwhile changes. While metrication could provide the opportunity or vehicle for such changes, there is no assurance of achieving them. Also, it generally was undeterminable whether the cost of metrication would be offset by the value of the ascribed benefits. Of greater importance was the fact that most, if not all, desired changes could be achieved under the present measurement system.

These benefits could also occur with the replacement of obsolete equipment and facilities or when other changes occur. If equipment or facilities are subjected to premature obsolescence because of metrication, this would increase the metrication cost. Any increased efficiencies due to new equipment would have to be weighed against the cost of the change to determine whether or not metrication would result in a net benefit.

Whenever the question of metrication benefits is brought up throughout the metric movement, increased standardization

and rationalization is given as the answer. Standardization occurs when the number of standard items and products increases. Rationalization occurs when a limited set of product sizes in a rational series is established. Eventually all sizes not in the series are eliminated, generally resulting in a reduction in the number of sizes.

Present sizes have developed over the years in the marketplace to meet demand. For some products, industry officials believe that most of these sizes meet their needs. Substantial standardization and rationalization has been achieved under the present customary system and is a continuing goal.

There is little doubt that increased standardization and rationalization could result in benefits, but the costs of achieving these ascribed benefits are unknown. Increased standardization and rationalization could be achieved using our customary system, but proponents view metrication as an opportunity or vehicle to achieve the results. However, metrication would result in dual inventories of customary- and metric-size items for a considerable amount of time, particularly in those industries where equipment has a long life and spare parts have to be maintained. This would be a very critical problem for many industries, suppliers, and retailers and would cost an undeterminable amount. Only after the period of dual inventories has elapsed would it be known whether increased standardization and rationalization has resulted and at what costs. Also, if metrication occurs, many standards will have to be reviewed at substantial cost in time and money.

There is little assurance of achieving increased standardization and rationalization because the use of standards and the selection of product size is generally on a voluntary basis in the United States. Some other countries have more control over standards and the size of products. Also, there is little assurance that a new proliferation of sizes would not occur even if initial standardization and rationalization can be achieved. It appears that Government controls might be required to help ensure that standardization and rationalization would be achieved and maintained. We believe this generally would be opposed by the American people and industry.

Some persons claim that consumers will benefit because the metric system is easier to understand and price comparisons will be easier to make. The premise that price comparisons could be made easier depends on the willingness and ability of producers to change to rational series of sizes. It is quite likely that changes to government laws and regulations would be needed to ensure that rational package sizes

would be used. For some containers, such as cans, size conversions would require a considerable expense that quite likely would be passed on to consumers in the form of higher prices.

It may be that the increased use of unit pricing would be of greater benefit to consumers than converting many sizes to metric. Unit pricing would facilitate price comparisons and be easier to understand. Unit pricing is not dependent on the use of standard or rational sizes, which can be difficult and costly to achieve, and would permit producers to make their products in sizes relating to their needs.

There is no compelling reason for many consumer products and sports to convert. For most consumer products and for activities such as sports, no major benefits would occur to either producers or consumers by converting to the metric system. Many consumer products are not exported to other countries; producers of those that are seem to have little problem with the measurement system used. Other countries exporting products to the United States change the sizes of their products to U.S. sizes when necessary.

COSTS

The total cost of metrication for the United States has not been determined, and it appears that it is difficult to develop a valid estimate. Australia, Canada, and the United Kingdom were unable to do this for their conversions. The 3-year NBS study published in 1971 also was unable to provide such a figure.

Proponents have claimed that while costs would be incurred to convert, the costs of not converting would be greater. These latter costs are viewed as opportunities lost by not converting. As difficult as it is to determine the cost of conversion, it would be even more difficult to estimate the cost of not converting.

Generally, the initial metrication cost estimates for a company have been higher than the actual cost. This seems to occur because an organization's initial reaction to metrication is that many machines, other assets, and supplies will have to be replaced. However, once a decision to convert is made and suborganizations are told that they are to absorb the cost or a central body is appointed to review all claimed metrication costs, the next cost estimate invariably is less. They take courses of actions which minimize the conversion costs. This is not to say that the costs are not large or that they would outweigh potential benefits or vice versa.

Generally the necessary cost information is unavailable to make such a determination.

Most businesses that are converting told us they did not keep track of metrication costs but just absorb them in their normal operations. Cost information is considered proprietary by most firms, and therefore, metrication cost data was seldom released to us even when available. However, the majority of firms believed that metrication costs would be substantial. Our review showed that whatever the costs, they generally will be passed on to the consumer.

If metrication can be phased into an operation under a normal replacement program, the cost would be much less than if items have to be replaced earlier than normal just to make them metric. Also, if a conversion kit is used or a part replaced rather than replacing the entire item, the cost is much less. This is assuming some outside force or pressure does not dictate conversion at an inopportune time or manner. An example of this would be if a major customer required all its suppliers to provide metric products and supplies. A supplier probably could not afford to lose this major customer's business and would have to convert some, if not all, operations to metric and replace equipment before its useful life had expired.

Some of the major cost areas include training and educating people; converting computer systems, data bases, and standards; changing laws, regulations, ordinances, and codes; maintaining dual inventories; purchasing hand tools; changing product sizes; and familiarizing consumers with metric terms.

Personnel would have to be trained but the costs can be minimized by providing only what is needed, to those who need to know, and when they need to know it. But some segments of organized labor want a much broader training program for all workers. Metrication could result in decreased productivity temporarily as employees acquaint themselves with the new terminology and product sizes.

State education authorities feel that metric education can be incorporated into the school program at little cost after teachers are trained. However, costs for travel to training sessions, payment of substitute teachers while regular teachers are being trained, and stipends to teachers for additional time in training and purchase of materials could be substantial. On the other hand, in the classroom metric instructional materials and textbooks can be provided at little or no expense as expendable materials are replaced and textbooks are obtained during a normal replacement cycle.

In addition to formal education, there would also be a cost for a public information program which would have to be conducted both on a national and local level by all segments involved in converting both in the public and private sectors. They all would have a responsibility in educating consumers in understanding and using the metric system.

Conversion of computer systems and data bases, along with other administrative material, could be a significant cost, but there is very little metrication experience in this area to date.

It is generally recognized that converting existing standards or developing new metric standards would be costly and time consuming. We were not able to obtain an overall estimate of how much these costs would be.

It is generally agreed that for many industries the cost of maintaining dual inventories of customary- and metric-size parts for many years will be significant. Many industries would want the shortest feasible conversion period to shorten the period of dual inventories. Others would want to extend the conversion period in order to alleviate some of the costs of equipment adjustments and replacements by having the changes take place at an opportune time--generally when a change would have to be made for other reasons such as replacement due to obsolescence or worn-out equipment.

In some cases, workers' metric tools have been provided by the employer. These costs would be passed onto customers in the form of higher prices for products or services. In other cases, workers must purchase their own tools, the cost of which then becomes a tax deductible item to the extent permitted. Government subsidies have been proposed by some for the purchase of metric tools needed by U.S. workers. In this case the cost would be passed onto the taxpayer.

Metrication would require reviewing laws, regulations, ordinances and codes at all levels of government in the United States to see whether there are measurement-sensitive provisions that would need to be changed. This would be an enormous undertaking. It could be viewed as an opportunity to make improvements and eliminate those laws, regulations, ordinances and codes which are obsolete or unneeded. However, the process would entail the expenditure of a considerable amount of time and money.

COSTS LIE WHERE THEY FALL

One of the principles of metrication adopted by all the converting countries was to let the costs lie where they fall.

In other words, metrication would not be subsidized. There were some exceptions to this policy. The policy was recommended in the 1971 NBS metric study and has been adopted internally by most converting firms. Many firms have adopted this principle by requiring suborganizations to absorb metrication costs in their budgets and operations. If a suborganization, firm, or industry knows it will have to absorb the costs, there is a tendency to keep the costs down to remain competitive. However, in most cases it appears the costs will be passed on to the customer.

If Federal financial assistance is available, there could be a disincentive to control costs because someone else, in this case the taxpayer, would be picking up the tab. A number of industries indicated a desire for Federal financial assistance in their conversion efforts. However, this would likely proliferate because once one sector is granted assistance, undoubtedly others will want assistance also. Already there has been some discussion about the need for assistance for the scale and apparel industries, small businesses, and labor. The 1975 Act did not establish a cost policy and did not provide for Federal financial assistance. Some of the converting countries, all of whom had a national commitment to metrication, did provide some financial assistance. Two of the four converting countries, that we were able to obtain information on, granted exemptions to taxes on the purchase of equipment relating to conversion on the premise that the government should not increase its revenues through conversion. Also, Canada provided financial aid for certain workers' metric tools.

We believe that the principle of having costs lie where they fall should be followed with regard to conversion activities. If a sector cannot convert without government assistance, then it would appear that it may not be in that sector's best interest to convert to the metric system.

SAFETY HAZARDS AND ERRORS

Concern has been voiced in several areas about safety hazards occurring during a metric conversion. One area of concern is domestic air operations. In the United States, all air operations use a standard for measurement which is based entirely on the customary system. The U.S. aviation community sees no reason for conversion. Aviation officials are concerned about safety if the terms used in air operations are converted to a total metric system. With the number of aircraft and persons flying today, we have been told by those involved that there might be serious air safety consequences to such a mass conversion.

There also has been some concern raised in the medical field about safety if all measurement terms are converted to the international metric system (SI). The medical field currently uses some metric terms that are not accepted in the international metric system.

The conversion of some home appliances where heat is involved has raised some concerns. The user might confuse Celsius and Fahrenheit terms and touch an appliance that was thought to be warm when it is actually very hot. The result might be a serious burn.

Industry might have a similar problem with thermometers and pressure gauges. For example, at an aluminum plants a control operator set a temperature gauge on a furnace at a level which he thought would heat an aluminum ingot to a workable temperature. However, the gauge was in Celsius rather than Fahrenheit and instead of a heated ingot, the inner furnace was covered with molten aluminum.

We do not know how serious these problems might be, but they are concerns that would have to be dealt with in a metric conversion.

METRICATION LESSONS LEARNED BY OTHER COUNTRIES

Regardless of the differences in physical and economic characteristics and types of governments between the countries that have converted or are in the process of converting--Australia, Canada, New Zealand, and the United Kingdom--and the United States, their experiences could provide valuable guidance if the United States adopts a national policy to convert. We believe these countries' metrication experiences have shown that certain principles should be adopted if the United States is to convert to a predominantly metric system of measure in an efficient and economical manner and within an optimum period of time. These principles or lessons learned and the current position in the United States are as follows:

Lessons learned by other countries	Status in the United States
(1) A clear and firm Government commitment to convert is necessary to achieve a successful conversion.	The United States has not adopted this policy, and there is much confusion as to whether the United States is committed to a metric America.
(2) A central body should be established early, shortly after the national commitment is made, to plan and coordinate the conversion and inform the various sectors and the public of metric activity.	The Metric Board had not become fully operational--over 2 years after the passage of the 1975 Act--at the time this report went to print.
(3) A well-developed plan must be prepared and effectively implemented.	There is no national plan and should not be under the current law and national policy. However, there is some coordination being done by the American National Metric Council, but most of it is very preliminary.
(4) A successful voluntary conversion must eventually become mandatory through laws and regulations, etc., in order that the metrication program can be completed. Necessary exceptions should be permitted.	The 1975 Act did not contain and the Metric Board does not have any compulsory powers.
(5) An overall target date must be established for the country by the Government, and specific target dates must be established for the various sectors by those affected.	No overall target date exists for conversion in the United States.

Lessons learned by other countries	Status in the United States
(6) The public must be adequately informed and educated, and responses must be made to consumer concerns. Conversion of the retail sector is the most difficult and must receive special attention.	These are some of the responsibilities of the Metric Board.
(7) The principle of letting costs lie where they fall should be adopted if at all possible. All the foreign countries did this, although a few made some exceptions.	To date there are no Federal metric assistance programs and none provided for in the Metric Conversion Act of 1975. However, about $6.3 million has been provided for metric education grants.
(8) The use of the Government's purchasing power greatly facilitates the conversion. (Government should be careful that it does not pick up the tab for an inordinate amount of private enterprise's metrication costs.)	Using procurement by the Federal Government as a means to effect conversion is one of the subjects mentioned in the 1975 Act that the U.S. Metric Board may examine.
(9) The conversion of certain sectors, such as sports and weather reporting, is an excellent means of educating the public.	The National Weather Service has a plan to do just this regardless of the current national policy. Some sports notably field and track and swimming, are using the metric system because world records are in the metric system. Under the current national policy, it would seem inappropriate to convert weather and sports for educational purposes.

Lessons learned by other countries	Status in the United States
(10) Avoid dual labeling (in both metric and the previous system) whenever possible, and keep the time period of dual usage to a minimum.	Many consumer food products are dual labeled. The Metric Board could encourage the adoption of this policy by those that decide to voluntarily convert, but it would be more appropriate under a national program with a firm Government commitment.

To assist firms and other organizations in the preparation of materials and products used for distribution or sale to the public, Canada established the capability to review proposed material for accuracy of metric terminology and permitted the use of their logo on approved material. This assures the public that the metric data is accurate. It is not intended to serve as an endorsement of the product.

Consumer or public reaction to metrication has been a major force in determining whether a conversion to the metric system can be successful in these countries. Experience has shown that if conversions of some consumer products are not handled properly, adverse consumer reaction results. Yet, these countries have also found that when consumers view metrication as not being harmful to their interests, conversion becomes a "non-event." It must be kept in mind, however, that all these countries had a national commitment by the Government to convert to the metric system.

In the United Kingdom, government officials, as well as industrial, retail, and consumer organizations wanted to limit the use of a dual system to as short a time period as possible. This highlighted the need for statutory cut-off dates which the 1976 Weights and Measures Act permits. This was to be accomplished by means of government orders which had to be approved by Parliament. Essentially this moved the program from the voluntary to the mandatory stage.

Orders have been approved by Parliament fixing dates to terminate imperial quantities for a number of prepackaged foods, including sugar, salt, [illegible] cornflakes, biscuits, and edible fats. However, orders proposed in 1978 for nonpackaged goods, such as loose fruits and vegetables, hardware, textiles, and floor coverings, were not approved because of public opposition. It has been reported that the government has abandoned,

its mandatory conversion program and is reverting to its voluntary conversion program. Thus, the retail sector in the United Kingdom is in a very confused state with some items being sold in metric units and other items remaining in imperial units. At this time we do not know what effect this action will have on the United Kingdom's conversion program but it is apparent that it will be some time before the retail sector is metric.

USING BOTH SYSTEMS

Although there is some use of the metric system, the United States is a predominantly customary country. We believe, along with most others, that the United States or any other country cannot effectively operate under a dual system of measurement. A dual system--usage about equally divided (ranging from 40 to 60 percent) between the two systems--would be inefficient, uneconomical, and confusing to everyone, especially the general public. Educators would probably be teaching both systems with somewhat equal emphasis. Laws, regulations, ordinances, and codes would be a confusing tangle using both systems.

OVERALL CONCLUSIONS

No country with a combined economy and population anywhere near the size of the United States has ever converted to the metric system. If there is a conversion, the specific effect it would have on our economy is undeterminable, but the impact on our society would be great.

There is insufficient evidence to support or refute the belief that conversion to the metric system by the United States is inevitable. But a nation or an organization should not convert simply because metrication is thought to be inevitable. However, as more people believe in inevitability and convert because of this belief, metrication then becomes inevitable. Before embarking on a full-scale national metric program sufficient justification, supported by evidence, must be provided to the American people.

Most of the cited metrication benefits are goals which have always existed and have been achieved to various degrees under the customary system. Metrication is being viewed by proponents as the opportunity to achieve them (to a greater degree). However, actually achieving the benefits is questionable, and their values are generally undeterminable.

The total cost of metrication is likewise undeterminable, in spite of various estimates that have been cited in the last decade by various organizations and individuals.

These estimates vary widely and often are not based on detailed analyses of the factors involved. They generally are low or high depending on the conversion experience of those providing these figures and their position on converting or not converting to the metric system.

However, based on the limited cost data that was available to us and the input from the various representatives from a wide spectrum of organizations throughout the country, the cost will be significant--in the billions of dollars. It would seem reasonable that if conversion is warranted, the principle of letting the costs lie where they fall should be adopted. Very likely if this principle could not be generally adhered to and substantial Government financial assistance was required, then conversion would not be justified.

In order to have the opportunity to achieve improvements or benefits, the conversion must be a hard conversion, a change in product dimensions, rather than a soft conversion, using metric equivalents. However, we question the reasonableness of changing the sizes of products where no changes are needed or justified.

Because most countries use the metric system of measurement, the United States cannot deny the existence of the system or prohibit its use. It should be noted that the extent to which each country adopted and uses the entire international (SI) metric system is unknown.

A multitude of factors affect world trade, and the measurement system used is considered to be of minor importance. A majority (60 percent) of the largest U.S. industrial businesses--the Fortune 500--who responded to our questionnaire believed conversion would facilitate trade through a common measurement language, but over 80 percent indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms responding cited factors such as competitive prices, high quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. Engineering standards and the design and manufacture of products in either metric or customary units were considered to be of major significance in promoting trade by relatively few of the respondents. Less than 5 percent of the respondents considered measurement units to be a major significance in deterring trade.

American firms have been trading for centuries with countries that (1) use various measurement systems, (2) have different requirements and laws that must be complied with,

and (3) speak different languages. We found no evidence to show whether the Nation's trade would be significantly affected by converting to the metric system or remaining with the customary system.

A matter to be considered is whether the demands for the use of the metric system in world trade warrant the effort and expense needed to convert our day-to-day affairs, such as highway speed limits, consumer products, and weather reporting, into metric measures.

Actions by Federal agencies, multinational firms, educators, and others aided by a general feeling of inevitability and misstatements about metrication throughout the country tend to forge a metric policy for the entire Nation. A policy to convert to the metric system should be made by the representatives of the people--the Congress. It appears to us that under the present policy and the current trend of events, the United States will eventually become a predominantly metric country.

Current policy has been misinterpreted, and within this context attempts have been made to convert to the metric system. It would seem that as a minimum, before voluntarily deciding to convert, there should be

--a clear understanding of the policy,

--knowledge of the costs and benefits involved,

--an assessment of the impact on the sector involved and any related sector, and

--a determination of the impact on consumers.

Any attempts to arbitrarily increase metrication activity could seriously undermine existing policy and lead to unnecessary metrication. Due care, therefore, must be exercised in carrying out the policy.

There is no question that one system should be predominant because the existence of a dual system for any length of time is impractical, inefficient, uneconomical, and confusing. It is not too late to make the decision as to which system is to be predominant. The decision is not an easy one because valid national conversion costs and the value of any benefits are not available.

Since a decision will affect every American for decades to come, we believe the decision, which is to continue with

the current policy or change it, should be made by the representatives of the people--the Congress.

We believe that this report will provide valuable information on metrication and the issues involved to the Congress, the Administration, the U.S. Metric Board, and to the American people.

Specific recommendations pertaining to measurement activities regarding fasteners, transportation, tires, petroleum, State governments, education, beverages, consumer products, and weather are discussed in the respective chapters of this report and for the most part are not included in this chapter. We are making the following recommendations to help implement the current national policy in accordance with the 1975 Act and its legislative history.

RECOMMENDATIONS

We recommend that the U.S. Metric Board:

--Inform the American people that conversion is strictly voluntary and that our national policy does not favor the metric system over the customary system, or vice versa.

--Ensure that its policies and actions do not advocate or discourage the use of one system over the other.

--Ensure that if a voluntary metrication proposal is presented to the Board, that all affected parties are adequately represented in the voluntary decision-making process.

--Hold public hearings on those conversion plans that affect the general public to obtain their comments which should be considered in finalizing such plans.

--Make provisions to handle questions and complaints by the general public in an expeditious manner.

--Adopt a national metric symbol (logo) to be used only on materials that the Board has reviewed for accuracy and completeness and make the public aware of this designation.

--In planning and coordinating conversion activities of U.S. industries involving the adoption of international standards, give consideration to those conversion activities that have taken place, such as that of the

U.S. fastener industry in its attempt to achieve (1) adoption of its proposals for international standards and (2) the benefits of standardization and rationalization.

--Use the experience gained in the conversion of the wine and distilled spirits industries in reviewing plans for other sectors, especially those involving consumer products.

--Develop avenues through which the States may define their roles and coordinate appropriate voluntary conversion activities among other States under the current national policy.

--Ensure that State education agencies and the U.S. Office of Education coordinate the timing of metric conversion in education so that metric instruction in schools will be in phase with the needs of the Nation in order that time, effort, and money will not be expended to develop and teach a predominantly metric program to students for a still nonmetric society. Educators must be reminded that U.S. policy at this time is voluntary, which includes the option not to convert.

--Consider the information and specific recommendations contained in the chapters of this report in reviewing any conversion plans submitted to the Board.

We recommend that the Director, Office of Management and Budget, in working with the U.S. Metric Board:

--Clarify for Federal agencies what they are expected to do in regard to planning and coordinating any increased use of the metric system.

--Ensure that Federal agencies establish policies consistent with the intent of the Metric Conversion Act of 1975 and inform the private sector of Federal metrication plans whenever appropriate.

--Ensure that Federal agencies convert regulations or mount other metrication activities when the initiative comes from the sectors which will be affected--industry, the States, and the general public. Federal agencies should only initiate action when they can demonstrate that such action is in the Nation's best interest.

--Require that Federal agencies inform the public of the impact of those conversion actions that affect them and hold public hearings to obtain their comments which should be considered in any final determination on such actions.

AGENCY COMMENTS AND OUR EVALUATIONS

In an August 7, 1978, letter commenting on our report (see app. I), the U.S. Metric Board's Ad Hoc Committee (Board), established to comment on our report, stated that the report contained detailed information on the status of voluntary conversion in many sectors of the economy which will be used by the Board. However, the Board was in disagreement with some aspects of the report. It stated that:

> "The Executive Summary does not seem to reflect adequately some of the thoughtful analyses contained in the body of the Report, and in some instances the Summary distorts the objectivity of the body of the Report."

We disagree with this contention and were unsuccessful in having the Board specifically identify those statements in the report and the Executive Summary that support this claim. 1/ The Executive Summary is simply a summary of the material contained in the body of the report and cannot include all the detailed analyses.

The Board commented that the data obtained was not evaluated in detail for its validity, as acknowledged in the report. Our statement regarding the validity of the data refers only to the information about other countries which we obtained from various sources, summarized, and sent to the respective Metric Board or Commission of the four countries cited in our report with a request for their review and comments. We did not evaluate these responses for their validity because we would have had to do detailed analyses in all four countries. In the United States we were able to deal directly with the responsible individuals involved especially in the private sector and did not have to obtain information through a Government metric board or commission.

1/We received an August 14, 1978, letter from a member of the U.S. Metric Board, disagreeing with the Ad Hoc Committee's comments, particularly the above quoted comment.

The Board stated that the Summary implies that there is no national policy now regarding metrication. The Board cites the policy set forth in the 1975 Act and continues by stating:

> "In a letter from the White House to the Executive Director of the American National Metric Council on December 31, 1975, President Ford stated:
>
> > 'The Metric Conversion Act of 1975, H.R. 8674, which I signed on December 23, sets a national policy of converting to the metric system and established a United States Metric Board to coordinate efforts for voluntary conversion.'
>
> "The Report states that the national policy is not generally understood, but by the very creation of a Metric Board the Act has provided a mechanism for minimizing any misunderstanding.
>
> "In passing the Metric Conversion Act of 1975, Congress committed its support for voluntary conversion to a metric measurement system and created a Board to coordinate it. Now that the United States Metric Board has been confirmed, with proper staffing and budgeting, it will help to provide a clear understanding of what is involved in metric conversion and what benefits the country can hope to realistically achieve. Representatives of various sectors in the economy serve on the Board so that the impact of voluntary conversion on each will be fully considered."

The report clearly states that the national policy is not to prefer one system over the other but to provide for either to be predominant on the basis of the voluntary actions of those affected. Our review of the legislative history of the Metric Conversion Act of 1975 showed that the Congress did not commit itself to conversion to the metric system but allows for conversion by the voluntary actions of those affected. Congressional intent is established by the Congress and not by a letter from the White House to a metric organization incorrectly stating that the act set a national policy of converting to the metric system. The quoting of such letters especially by the Metric Board, adds to, not minimizes, the misunderstanding of our national policy.

The Metric Board's responsibility under the act is to devise and carry out a broad program of planning, coordination, and public education, consistent with other national

policy and interests, with the aim of implementing the policy set forth in the act. It is to serve as a focal point for voluntary conversions to the metric system. The Board is not to advocate metrication but is to assist various sectors when, and if, they choose to convert.

As pointed out by the Board, this report contains information that will be used by the Board. We believe this information will be beneficial and hope that the information on benefits and costs and advantages and disadvantages contained in the various chapters should be provided to the public in the Board's public information programs.

With respect to cost, the Board pointed out that:

"Conversion to metric can be discussed both from the position of advantages and disadvantages, as treated in the Report. The question of cost, however, cannot be easily quantified, because the Report fails to point out that conversion costs are a one time investment, while benefits are continuous. It fails to provide adequate analysis to support the contention that 'conversion would be enormously expensive.'"

One of the ascribed disadvantages frequently attributed to metric conversion is that it would be enormously expensive. This is one of the generally ascribed disadvantages as well as advantages mentioned in the report and discussed more fully in chapter 3. We found this was one of the principal arguments used in discussing the issue of metrication. For example, estimates given in the legislative debate on the Metric Act reached up to $100 billion, and the National Federation of Independent Businesses advised that the major portion of the cost would be passed on to the consumer. Costs may be a one-time significant investment over a long period of time, but as shown in our beverage case study, consumers pay an increased cost every time they buy that product.

With respect to benefits, the results of our review showed that few benefits could be directly attributable to metrication. There is no assurance that the ascribed advantages (benefits) can be achieved and most, if achievable, could be accomplished under the customary system. The Board offered no support for benefits to be achieved by converting to the metric system.

The Board stated that the status of metric conversion in other countries should be updated to reflect current conditions. This information is current as the information was obtained from these countries in 1978. The only exception

was the public reaction against metrication in the United Kingdom which occurred when many retail areas, such as fruits and vegetables, hardware, and floor coverings and tiles were were scheduled for conversion very recently.

The Board in its comments cited the following general belief:

> "The fact that the United States is the only major nation not converted to the use of the metric system has led leaders in industry, labor, government, and the consumer movement to recognize that metrication is in the best interests of the United States in the long run. Their voluntary metric actions are in response to this international situation and are not occurring because of the so-called 'inevitability syndrome.' Therefore, contrary to what the Summary recommends, no action is considered necessary to combat the so-called 'inevitability syndrome,' nor should this lead us to ignoring domestic and international realities. A clearer definition of this syndrome should be provided to distinguish between the United States when interfacing with other nations versus factors affecting the United States in its internal operation."

The fact that many companies are converting because they believe conversion is inevitable is supported by our questionnaires and direct contact with knowledgeable industry representatives. As explained in the report, the inevitability syndrome, coupled with the ripple effect, generates an atmosphere of conversion to the metric system which appears to be unwarranted.

Concerning the statement that labor has recognized that metrication is in the best interest of the United States in the long run, we are not aware of a major international union or affiliate of the AFL-CIO that has made such a statement.

If a company wishes to trade in a country, it must conform to the regulations of that country which may cover language, labels, sizes, and so on. As officials of the U.S. Office of the Special Representative for Trade informed us, measurement has not been defined as a trade barrier. Also, the use of metric measures could facilitate trade, but it is not a significant factor as reported in the 1971 NBS study and substantiated by our work.

A majority of large businesses believed conversion would facilitate trade because a common measurement language would come into use. Trade is also facilitated where the same language is used. But an even larger majority indicated they did not expect any significant change in either exports or imports as a result of conversion. A majority of the firms cited factors, such as competitive prices, high product quality, superior technology, and good reputation and reliability as being of major significance in promoting exports. The design and manufacture of products and engineering standards in either metric or customary units were not considered to be a significant trade factor.

With respect to consumer concerns, the Board stated that:

"The Metric Board recognizes that there is concern on the part of some consumers regarding metric conversion. This takes many forms, including the use of metric measurements in day-to-day living and in the market place with such factors as package sizing, and price in relation to metric units. An ongoing public information and awareness program will have high priority for Board consideration. As the Report states, the public must be adequately informed and offered useful education and appropriate responses must be made available for consumer concern."

We agree and believe this report will help to properly inform the consumers--all Americans--of the advantages and disadvantages of metrication. Any public information and awareness program conducted by the Board should inform the public of the potential benefits and costs involved.

Finally the Board stated that:

"The United States Metric Board will study the relative merits of various alternatives and if it deems that any changes in the present Law are necessary it will so recommend to Congress and the President in its Annual Report."

We trust this report will assist the Congress, the Administration, the U.S. Metric Board, and all Americans in becoming familiar with what is involved if metric conversion takes place in the United States.

UNITED STATES METRIC BOARD
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August 7, 1978

Honorable Elmer B. Staats
Comptroller General of the United States
General Accounting Office
Washington, D. C. 20548

Dear Mr. Staats:

The United States Metric Board appreciates the opportunity to comment on the extensive General Accounting Office study on "Weighing the Alternatives: Should the United States Adopt the Metric System?"

The body of the report contains detailed information on the status of voluntary conversion in many sectors of the economy and the information will be used by the United States Metric Board. While there are areas of disagreement between the United States Metric Board and the GAO Report, there is no desire to be disagreeable about it. Nor can the Board be unduly concerned about its own popularity while it devotes its best effort to this most serious and worthy subject.

The Executive Summary does not seem to reflect adequately some of the thoughtful analyses contained in the body of the Report, and in some instances the Summary distorts the objectivity of the body of the Report.

It is understandable that the scope of the study was limited as are all studies of this nature. It is important to note, however, that the data obtained was not evaluated in detail for its validity, as acknowledged in the body of the Report. Also no samples of questionnaires or other measuring devices were included in the main Report, and we believe the value of the Report would be enhanced if such references were covered. Each section of the Report has been reviewed in depth by members of the United States Metric Board and detailed comments will be submitted to GAO on or before August 21. The following comments are directed primarily to the Executive Summary.

The Summary implies that there is no national policy now regarding metrication. Yet, as the Report itself points out, in quoting from the Metric Conversion Act of 1975:

"***the policy of the United States shall be to coordinate and plan the increasing use of the metric system in the United States and to establish a United States Metric Board to coordinate the voluntary conversion to the metric system."

In a letter from The White House to the Executive Director of the American National Metric Council on December 31, 1975, President Ford stated:

"The Metric Conversion Act of 1975, H.R. 8674, which I signed on December 23, sets a national policy of converting to the metric system and established a United States Metric Board to coordinate efforts for voluntary conversion."

The Report states that the national policy is not generally understood, but by the very creation of a Metric Board the Act has provided a mechanism for minimizing any misunderstanding.

In passing the Metric Conversion Act of 1975, Congress committed its support for voluntary conversion to a predominantly[1] metric measurement system and created a Board to coordinate it. Now that the United States Metric Board has been confirmed, with proper staffing and budgeting, it will help to provide a clear understanding of what is involved in metric conversion and what benefits the country can hope to realistically achieve. Representatives of various sectors in the economy serve on the Board so that the impact of voluntary conversion on each will be fully considered.

Conversion to metric can be discussed both from the position of advantages and disadvantages, as treated in the Report. The question of cost, however, cannot be easily quantified, because the Report fails to point out that conversion costs are a one time investment, while benefits are continuous. It fails to provide adequate analysis to support the contention that "conversion would be enormously expensive." A part of the United States Metric Board responsibility is to investigate fully the costs and benefits involved so that any change can be economically and efficiently accomplished.

The Executive Summary comments on the status of metric conversion in other countries. This should be updated to reflect current conditions. Of course, a United States Metric Board must remain current in all such matters.

1/The Board stated it inadvertently used the word "predominantly" and requested that it be deleted.

The fact that the United States is the only major nation not converted to the use of the metric system has led leaders in industry, labor, government and the consumer movement to recognize that metrication is in the best interests of the United States in the long run. Their voluntary metric actions are in response to this international situation and are not occurring because of the so-called "inevitability syndrome." Therefore, contrary to what the Summary recommends, no action is considered necessary to combat the so-called "inevitability syndrome," nor should this lead us to ignoring domestic and international realities. A clearer definition of this syndrome should be provided to distinguish between the United States when interfacing with other nations versus factors affecting the United States in its internal operations.

The Metric Board recognizes that there is concern on the part of some consumers regarding metric conversion. This takes many forms, including the use of metric measurements in day-to-day living and in the market place with such factors as package sizing, and price in relation to metric units. An ongoing public information and awareness program will have high priority for Board consideration. As the Report states, the public must be adequately informed and offered useful education and appropriate responses must be made available for consumer concern. The Act clearly defines the responsibility of the Board on this matter, and any action to contravene this can be interpreted as an effort to deprive the public of facts concerning the metric system and its application.

GAO note; Material has been deleted because of changes in final report.

The Report suggests that decisions which affect so many people in our country should be made by the representatives of the people - the Congress. In passing the Metric Conversion Act of 1975, and the Education Amendments Act of 1974, Congress has done just that.

The United States Metric Board will study the relative merits of various alternatives and if it deems that any changes in the present Law are necessary it will so recommend to Congress and the President in its Annual Report.

In considering the Metric Act, the Congress gave this subject thoughtful consideration and careful analysis before passing the Act overwhelmingly. Wisdom reasons that it deserves an opportunity to function in the best interests of all United States citizens. Under such circumstances the Metric Act is a careful statement of Congressional intent.

We hope the above comments will be helpful to you in revising the Executive Summary.

Sincerely,

for Satenig St. Marie
Roger E. Travis
Co-Chairpersons,
Ad Hoc Committee

Copy: Dr. L. F. Polk
Dr. M. E. O'Hagan

ASSOCIATIONS, COMPANIES, ORGANIZATIONS, AND GOVERNMENTAL AGENCIES CONTRIBUTING INFORMATION FOR THIS REPORT

A & M Sheet Metal Co.
Abbott Laboratories
Abrams Aerial Survey
A. Brandt Company Inc.
Accoustical and Board Products Association
Ace Supply Co.
ACF Industries, Inc.
Acme Block & Supply Co.
Acme Foundry Inc.
Acme Industrial Products, Inc.
Acme Mills Co.
Acme Tag & Label Co.
Acorn Tool & Die
Adam Block & Sons, Inc.
A. Dayton Lovelady
Addressograph Multigraph Corp.
Adelaar Brothers, Inc.
Adele Simpson Inc.
Adelphia Automatic Sprinkler
A. De Swaan Inc.
Adolph Coors Co.
Advance Car Mover Co., Inc.
Aerospace Industries Association of America, Inc.
A. E. Staley Manufacturing Co.
Agway Inc.
Aiken Concrete
Airguard Industries Inc.
Airco Inc.
Air-Conditioning & Refrigeration Institute
Air Products & Chemicals Inc.
Air Transport Association of America
Ajax Hardware Corporation
Akron Standard
Akzona Inc.
Alcan Aluminum Corp.
Alcatraz Company
Alden Lyle Co.
Alexandria Drafting Co.
Allan S. Goodman Inc.
Allegheny Ludlum Industries
Allen Industries, Inc.
Allied Chemical Corp.
Allis-Chalmers Corp.
Alox Corporation
Alumax Corp.

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Aluminum Association, Inc.
Aluminum Company of America
Alwin Manufacturing Company
AMAX, Inc.
Amerace Corp. - ESNA Division
Amerada Hess Corp
American Apparel Manufacturers Association
American Architectural Iron Co.
American Artstone Company
American Asbestos Products Co.
American Association of Construction Engineers
American Association of State Highway and
  Transportation Officials
American Automobile Association
American Bakeries Co.
American Boiler Manufacturers Association
American Brands Inc.
American Broadcasting Cos.
American Can
American Ceramic Society
American Chain and Cable Co., Inc.
American Chapter/International Real
  Estate Federation
American Chemical Society
American Concrete Institute
American Concrete Pipe Association
American Congress on Surveying & Mapping
American Consulting Engineers Council
American Corporation
American Cyanamid Co.
American Dental Association
American Device Manufacturing Co.
American Federation of Labor and Congress
  of Industrial Organizations
American Federation of Small Business
American Frozen Food Industry
American Gear Manufacturing Association
American Hoist & Derrick Co.
American Home Economics Association
American Home Products Corp.
American Hospital Association
American Industrial Real Estate Association
American Institute for Design & Draft
American Institute for Imported Steel
American Institutes for Research
American Institute of Architects
American Institute of Constructors
American Institute of Landscape Architects
American Institute of Merchant Shipping
American Institute of Real Estate Appraisers

ANNEX I

American Institute of Steel Construction
American Institute of Timber Construction
American Insurance Association
American Iron and Steel Institute
American Land Development Association
American Landmark Corp.
American Lumber Standards Committee
American Management Association
American Manufacturing Co. Inc.
American Medical Association
American Motors Corp.
American Mutual Insurance Alliance
American National Metric Council
American National Standards Institute
American Paint Products Co.
American Paper Institute
American Petroleum Institute
American Pharmaceutical Association
American Plastic Products Co.
American Playground Co.
American Plywood Association
American Reinforcing Bar Producers
American Right of Way Association
American Road Builders Association
American Samoa Metrication Project
American Shipbuilders Council
American Sign and Indicator Corp.
American Society for Engineering & Education
American Society for Hospital Engineers
American Society for Landscape Architects, Inc.
American Society for Metals
American Society for Planning Officials
American Society for Quality Control, Inc.
American Society for Testing and Materials
American Society of Agricultural Engineers
American Society of Appraisers
American Society of Architectural Hardware Consultants
American Society of Civil Engineers
American Society of Concrete Construction
American Society of Interior Designers, Inc.
American Society of Heating, Refrigerating, and
  Air-Conditioning Engineers
American Society of Mechanical Engineers
American Society of Plumbing Engineers
American Society of Real Estate Counselors
American Society of Sanitary Engineers
American Specifications Institute
American Supply Association
American Standard Inc.
American Steel Works

American Trucking Association
American Welding Society
American Wood Council
American Wood-Preservers Association
American Wood Preservers Institute
AMF, Inc.
AMP Inc.
Amstar Corp.
Amsted Industries Inc.
Amtel Inc.
Amtower Orthopedic Appliances
Anaconda Co.
Anchor Hocking Corp.
Anderson Ford Inc.
Anderson Machinery Co.
Anderson-McGriff Co.
Andrew Obes Son Inc.
Anheuser-Busch Inc.
A. O. Green Refractories Co.
A. O. Smith Corp.
Apartment Owners and Managers Association
Apex Corporation
Apex Tool Works Inc.
Apex Wines-Liquors
A. Phillips & Sons
Appalachian Hardwood Manufacturers Association
Apparel Manufacturers Association of Canada
A. R. Abrams Inc.
Arbed Steel Co. of Luxemburg
Archer-Daniels-Midland Co.
Architectural Aluminum Manufacturers Association
Architectural Art Manufacturing
Architectural Woodwork Institute
Aris Products Co. Inc.
Armco Steel Corporation
Armstrong Cork Co.
Armstrong Rubber Co.
Arnold Glick & Co. Inc.
Aromatic Red Cedar Closet Lining Manufacturers Association
Arthur F. Schultz Co.
Arthur H. Freedberg Co.
Arvin Industries, Inc.
Arvin Water Co.
Asarco
Ashland Oil Inc.
Ashton Brothers Co.
Ashton Lewis Lumber Co. Inc.
Asphalt Institute
Associated Builders & Contractors, Inc.
Associated Food Equipment Co.

Associated General Contractors of America
Associated Milk Producers
Associated Sandblasting Contractors
Associated Specialty Contractors
Associated Student Products
Association of American Railroads
Association of Asbestos Cement Pipe Products
Association of Asphalt Paving Technologists
Association of Canadian Distillers
Association of Drilled Shaft Contractors
Association of Home Appliance Manufacturers
Association of Steel Distributors
Association of University Architects
A-T-C Inc.
Atlantic Richfield Co.
Atlantic Varnish and Paints
Atlas Automation, Inc.
Atlas Corrugate Case Co. Inc.
Atwell Co.
Atwood Adhesive Inc.
Aufdemkampe Hardware Co.
Aurora Blacktop Inc.
Austin A. Baker Estate
Auto Cast Inc.
Auto Chlor System Inc.
Automated Procedures for Engineering Consultants
Automotive Service Councils, Inc.
Auto Parts Co. Inc.
Avalon Classics Inc.
Avco Corp.
Avery International
Avnet Inc.
Avon Products Inc.
Babcock & Wilcox Co.
Badger State Bank (WI)
Badgett Steam Lubricator Co.
Bailey Lumber Company
Baker International
Ball Corporation
Ballymore Company
Bank of Currituck (NC)
Bank of Hydro (OK)
Bank of Lemmon (SD)
Bank of Lyon County (KY)
Bank of Woodstock (GA)
Barker Advertising
Barmakian Brothers
Barnett Optical Co.
Barnstable County Supply Co.
Bauer Industries Inc.

Bausch & Lomb
Baxter Land Co. Inc.
Baxter Travenol Laboratories, Inc.
B & B Tool & Die Co. Inc.
Beaco Equipment Company
Beamis Co. Inc.
Beatrice Foods Co.
Bechtel, Inc.
Becton Dickenson & Co.
Beech Aircraft Corp.
Belco Petroleum Corp.
Bell & Howell Co.
Bellas Co. Inc.
Belle Isle Apartments
Bendix Corp.
Berghausen Chemical Co.
Bergman & Isaac
Berkel Inc.
Berringer Brothers Wine Co.
Bethlehem Steel Corp.
Bethlehem Suburban Motor Sales
Better Brands of Atlanta Inc.
B. F. Goodrich Co.
B & H Tool & Machine Corp.
Bill Collins Ford
Bill Garrett Chevrolet Inc.
Billy the Kid
Bilt Rite Construction Co.
Biosearch
Bishop Distributing Co.
Bituminous Pipe Institute
Black & Decker Manufacturing Co.
Black River Quarry Inc.
Blakely Laundry Co.
Blissfield State Bank (MI)
Bliss Steel Products Corp.
B. & L. Machine Company
B. L. Marder Co.
Blom Industries Inc.
Blue Bell Inc.
Bluebird Inc.
Blue River Sand & Gravel Co.
Boeing Company - The
Boichot Concrete
Boise Cascade Corp.
Boland Marine & Manufacturing Co. Inc.
Bone Inc.
Boone State Bank (IL)
Boonville Manufacturing Corp.
Borden Inc.

Borg Warner Corp.
Boro Lumber Co. Inc.
Bosak Motor Sales Inc.
Boston Digital Corp.
Bouma Tile & Acoustical Co.
Bowdil Company
Brake Supply Co. Inc.
Brandon Applied Systems, Inc.
Branom Instrument Co. Inc.
Brattle Instrument Corp.
Brennan Brothers
Bresee Chevrolet Co. Inc.
Brewers Association of Canada
Brick Institute of America
Bricklayers, Masons, & Plasterers International
  Union of America
Bristol Myers Co.
British Aircraft Corp.
British Government
    British Embassy
    British Standards Institute
    Department of Prices and Consumer Protection
    Metrication Board
Bronxville Public Schools
Brockway Glass Inc.
Brooks Foundry
Brown Group Inc.
Brown & Root, Inc.
Brown and Sharpe Manufacturing Co.
Bruce H. Rittenburg III
Brunswick Box Co.
Brunswick Corp.
Buchanan-Cellers Grain Co.
Buchman & Buchman
Buchyrus-Erie Co.
Budd Co.
Buell's Speedometer Service
Builders' Hardware Manufacturers Association
Building Officials & Code Administrators International
Building Owners & Managers Association International
Building Research Institute
Building Stone Institute
Burleson State Bank (TX)
Burlington Industries Inc.
Burlington Sign Company
Burroughs Corporation
B. W. Controls Inc.
C. A. Briggs Company
Cabot Corp.

Caldwell Distribution Co., Inc.
California Property Broakers Ltd.
California Redwood Association
Calmar Manufacturing Company Inc.
Calnap Tanning Co.
Cameron Iron Works, Inc.
Campbell Soup Co.
Campbell Taggart Inc.
Canadian Beverage & Glass Association
Canadian Construction Association
Canadian Farm and Industrial Equipment Institute
Canadian Home Economics Association
Canadian Hospital Association
Canadian Soft Drink Association
Canadian Wine Institute
Canadian Wood Council
Can Manufacturers Institute
Cannon Mills Co.
Capital Machine Co. Inc.
Capitol Engraving Co.
Capitol Toy Distributors Inc.
Carborundum Co.
Cardunal Savings & Loan Association (IL)
Carl Heinrich Co. Inc.
Carl I. Schaeffer Electric Co.
Carling-National Breweries, Inc.
Carlsbad Auto Co.
Carlton National Bank (MN)
Carnation Co.
Carney Buick Company
Carollo Construction Co.
Carrier Corp.
Carroll Independent Fuel Co.
Carrollwood State Bank (FL)
Cary Publications Inc.
Casey Sound Systems Inc.
Cast Iron Pipe Research Association
Cast Iron Soil Pipe Foundation
Cast Iron Soil Pipe Institute
Castle & Cooke Inc.
Castle Cars Inc.
Cast Specialties Inc.
Catawba College
Caterpillar Tractor Company
Caudill Rowlett Scott, Inc.
Cavalier Press, Inc.
Caxton Printers Ltd.
CBS, Inc.
Ceiling & Interior Systems Contractors Association

Celanese Corp.
Cellular Concrete Association
Cel-U-Dex Corporation
Center Chevrolet Inc.
Central Apex Engraving Co.
Central Beer Distributing Co., Inc.
Central Investment Corp.
Central Liquor Store, Inc.
Central Ohio Breeding Association
Central Rubber Co. Inc.
Central Soya Co. Inc.
Central Washington Grain Growers Inc.
Central Wood Preserving
C. E. Pennington Co.
Cereal Institute
Cerro-Marmon Corp.
Certain-Teed Products Corp.
Certified Ballast Manufacturing Association
Cessna Aircraft Company
CF Industries, Inc.
Chain Link Fence Manufacturers Institute
Chamber of Commerce of the United States
Champion International Corp.
Champion Spark Plug Co.
Charles D. Best, General Contractor
Charles H. Beckley Inc.
Charter Co.
Cheeseborough Ponds, Inc.
Chemetron Corp.
Chemray Coatings Corporation
Chem-Trand Inc.
Cherokee Industries Inc.
Chesterfield Yarn Mills Inc.
Chetek State Bank (WI)
Chicago Bridge and Iron Company
Chicago Sanitary Rag Co.
Chicago State University
China Trade & Industrial Service
Christian Brothers Wine Company
Christian County Farmers Supply
Chromallow American Corp.
Chrysler Corporation
Cincinnati Milacron Inc.
Cities Service Co.
Citizens Bank (MO)
Citizens State Bank (KS)
Citizens State Bank (ND)
Citizens State Bank (TX)
Citizens Telephone Co. Inc.
City of St. Louis Park, Minnesota

C. J. Erickson Plumbing Co.
Clarence Cardin
Clarence Dixon Cadillac Inc.
Clark Equipment Co.
Clark Oil & Refining Corp.
Clements Supply Co. Inc.
Cleveland Grocery Co.
Cleveland Ignition Co.
Cleveland Mills Company
Cleveland State University
Cleveland Steel Container
Clipper International Corp.
Clorox Co.
Clover Farms Dairy
Cluett Peabody &. Co, Inc.
Cobbs Manufacturing Co.
Coca Cola Bottling Co. Inc. (IN)
Coca-Cola Co.
Colgate Palmolive Co.
Collins & Aikman Corp.
Colonial-Petz Corp.
Colt Industries Inc.
Columbia Pictures Industries, Inc.
Column Research Council
Comatic Laboratories, Inc.
Combustion Engineering Inc.
Comfort Brick & Tile Co.
Comfort Chair Company
Commercial Bank (MO)
Commercial State Bank (IL)
Commercial Warehousing Co.
Commissioner of Baseball
Commonwealth Oil Refining Co.
Commonwealth University
Computer & Business Equipment Manufacturers Association
Concrete Products Co.
Concrete Reinforcing Steel Institute
Cone Agra, Inc.
Cone Mills Corp.
Conference of American Small Business Organizations
Consoleum Corp.
Consolidated Aluminum Corp.
Consolidated Foods Corp.
Construction Industry Manufactuers Association
Construction Specifications Institute
Construction Writers Association
Consumers Association of Canada
Consumers Financial Services
Consumers Gas Co. Inc.
Container Corp. of America

Continental Glass Co.
Continental Group, Inc.
Continental Oil Co.
Continental Trailways
Contractors Supply Co.
Control Data Corporation
Controlled Atmosphere Processing, Inc.
Cook Industries
Cookson Company
Cooling Tower Institute
Cooney Industries Inc.
Co-operative Union Merc. Co.
Cooper Industries Inc.
Cooper Tire and Rubber Co.
Cope Rendering Co.
Copper & Brass Fabrication Council
Copper Development Association, Inc.
Cora-Tx Manufacturing Co.
Corning Glass Company of Canada
Corning Glass Works
Coronet Fashions
Corra Plumbing Co. Inc.
Cotter and Company
Council of Education Facility Planners
Council of State Governments
CPC International Inc.
Crane Co.
Creative Living System Inc.
Creative Universal, Inc.
Crescent Food Co.
Crescent Machine & Nipple
Crest Apparel Co. Inc.
Crestview Vault & Memorial Co.
Creswell Insurance Agency
Cronin Supply Co. Inc.
Crosby-Whipple Oil Corp.
Crown Central Petroleum Corp.
Crown Cork & Seal Co., Inc.
Crown Zellerbach Corp.
Crystal Heating & Smet Co.
C. Schmidt and Sons, Inc.
C. S. Ohm Manufacturing Company
Cultured Marble Institute
Custom Built Cabinet & Supply
Cummings Leather Co. Inc.
Cummins Engine Co.
Curtiss-Wright Corp.
Curtis Universal Joint Co.
Custom Fabrics Inc.

Custom Industrial Park Pasco
Cutler-Hammer Inc.
Cyclops Corp.
Cyrus W. Scott Manufacturing Co.
Dairylea Cooperative, Inc.
Dana Corp.
Dana Printing Co.
D. & S. Die and Mold Inc.
Dane Manufacturing Co. Inc.
Dan River Inc.
Danside Fabrics Inc.
Dan Tucker Equipment Co.
Darby Buick Inc.
Dart Drug
Dart Industries Inc.
Data General Corporation
David B. Robinson
Daw Printing Ink Co.
Dayco Corp.
D. B. Enterprises, Inc.
De Bourgh Manufacturing Co.
Dedoes Industries Inc.
Dee Nelson Flowers-Gifts
Deer Creek Compress Co. Inc.
Deere & Co.
Delano Granite Inc.
Del Mar Die Casting Co.
Del Monte Corporation
Delta Associated Industries
Delta Microwave
Deltide Fishing-Rental
Demor's Northway Lincoln Mercury
Dennis Rzadko's Tires and Wheels, Inc.
Derby Grain, Inc.
Deston Co.
Developmental Sciences Inc.
Diablo Systems Incorporated
Diamond Ice & Coal Co.
Diamond International Corp.
Diamond Shamrock Corp.
Dick & Kirkman Inc.
Digital Equipment Corp.
Diskey Sign Corp.
Diso Corp.
Distilled Spirits Council of the United States, Inc.
District of Columbia
    City Council
    Department of Education
Dixie County State Bank (FL)
Dixie Distributing Co. Inc.

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Dixie Electric Co.
Dixie Engraving Company
Dixie National Stockyards Inc.
Dixie News Co. Inc.
DoAll Company
Doces Sixth Avenue Inc.
Doerr Electric Corp.
Dominion Lock Inc.
Don Jensen Construction
Door Operator & Remote Control Manufacturing Association
Door Unit Manufacturing Corp.
Douglas Properties Corp.
Dover Corp.
Dover Peoples Bank & Trust Co. (TN)
Dow Chemical Co.
Dow Corning Corp.
Dr. Chateliers Plant Food
Dresser Industries Inc.
Dudden Elevator Inc.
Dumes Salvage
Dunlop & Johnston Inc.
Dupey Enterprises Inc.
Durable Woods Institute
Durant Chevrolet Co.
Du Teau Chevrolet Co.
Eagle-Picher Industries
Eastern Airlines
Eastern Gas & Fuel Associations
Eastern Nebraska Telephone
Eastman Kodak Company
Eaton Corporation
Eaton Foods Inc.
Ecolotec Inc.
Economics Laboratory, Inc.
Economy Sales-Supply
Edgebrook Development Corp.
Edgerton Co-Op Creamery
Edlund Company Inc.
Educational Testing Service
Educators Industries Inc.
Edwin V. Lord
E. H. Bindley & Co. Inc.
Ehler Brothers Fertilizer
E. I. Dupont de Nemours, Inc.
E. J. McCarthy & Sons.
Electrification Council-The
Elias Industries Inc.
Elk State Bank (KS)
Elliots Inc.
Elmer Logsdon

Eltra Corp.
Eli Lilly & Co.
Embassy of France
Embassy of Mexico
Emerson Electric Co.
Emhart Corporation
Empire Contracting Co.
Empire Tool Co.
Encyclopedia Britannica Educational Corporation
Engineers Joint Council, Inc.
Entwisles Concrete Block Inc.
Envirotech Corporation
Equipment Corp. of America
Equitable Securities Corp., (TN)
Erickson Corp.
Erlanger Perpetual Building and Loan Association
E. R. Snell Contractors Inc.
Esmark Inc.
Ethyl Corp.
European Community Information Service
Evans Products Co.
Excel Electric Service Co.
Ex-Cell-O Corp.
Exmoor Knitwear Co. Inc.
Expanded Shale Clay and Slate Institute
Exxon Corp.
Fab-Alloy Company
Facing Tile Industries
Facing Tile Institute
Fairbairn Electric Inc.
Fairchild Camera & Instrument
Fairchild Machine Co. Inc.
Fairmont Foods Co.
Famariss Oil Refining Co.
Fannin & Son
Far East Conference
Farm and Industrial Equipment Institute
Farm and Land Institute
Farmers and Merchants State Bank (KS)
Farmers and Merchants State Bank (MN)
Farmers Bank (MO)
Farmers Co-op Creamery
Farmers Co-op Elevator Co.
Farmers Co-op Exchange
Farmers Co-op Grain Association
Farmers Elevator Co.
Farmers Elevator-Merc. Co.
Farmers Grain of Dorans

Farmers National Bank (IL)
Farmers National Bank (MN)
Farmers Savings Bank (IA)
Farmers State Bank (NB)
Farmers State Bank (ND)
Farmers Union Elevator (ND)
Farmers Union Oil Co., (ND)
Farmland Industries Inc.
Fasteners Inc.
Fayette Farmers Co-Op
F. C. Mason Company
Federal Co.
Federal-Mogul Corp.
Federal Paper Board Co.
Federal Screw Products Inc.
Federal Screw Works
Federal Timber Purchasers Association
Federal Wholesale Toy Co.
Federation of Societies for Coating Technology
Fein Container Corp.
Felix M. Mendelson Co.
Ferdinand Gutmann & Co.
Ferro Corp.
Ferrys
Fessler Knitting Co.
Fibre Leather Manufacturing Corp.
Fieldcrest Mills Inc.
Filter Material Inc.
Financial Computer Services
Fine Hardwoods-American Walnut Association
Fir and Hemlock Door Association
Fireline Inc.
Firestone Tire & Rubber Co.
First Growth Capital Inc. (OK)
First National Bank (CO)
First National Bank (CT)
First National Bank (IA)
First National Bank (IL)
First National Bank (KS)
First National Bank (KY)
First National Bank (MO)
First National Bank (NB)
First National Bank (ND)
First National Bank (OK)
First National Bank (TX)
First National Bank (VA)
First State Bank (MN)
First State Bank (TX)
Flat Glass Marketing Association

ANNEX I

Flavorland Industries
Fleetwood Enterprises
Flexible Pavements, Inc.
Flint Creek Valley Bank (MT)
Flintkote Co.
Florida Merchant Police Inc.
Flour Corporation
Flowers Baking Co. Inc.
Floyd Rice Ford Inc.
FMC Corp.
F. N. T. Industries Inc.
Food Marketing Institute
Ford Motor Company
Forest Products Research Society
Forke Brothers
Foster Wheeler Corp.
Foto Finishers Inc.
Fourdruner Kraft Board Institute
Fowler-Bourg Co. Inc.
Fowler Roofing Co. Inc.
Foxboro Co.
Frank Bancroft Co., Inc.
Frank C. Gibson Inc.
Franzia Brothers Winery
Frederick & Herrud, Inc.
Freeland Gauge Co.
Freeman Co.
Freemark Abbey Winery
French Knitting Mills
French Oil Mill Machinery Co.
Friedland International Shopping Corp.
Fromm and Sichel, Inc.
Frontier Inc.
Frontier Press Company
Frontier Wholesale Co. Inc.
Frostie Freeze
Fruehauf Co.
Fruit Auction Sales Co.
F. X. Smith & Sons Company
GAF Corp.
Gallo Wine Company
Galvanized Ware Manufacturers Council
Gamache Ranches Inc.
Gannett Co.
Garber Co-op Association
Gardner-Denver Co.
Gastineau Lumber Co.
Gatco Bushing Co.
Gates Learjet Corporation
Gates Rubber Co.

ANNEX I

GATX
Gaylord Bros. Inc.
Gay-Tred Mills Inc.
G. B. Dupont Company Inc.
G. Buehler & Co. Inc.
G. C. G. Jewelry Manufacturing Corp.
G. C. M. Mills Inc.
G. D. Searle & Co.
Gear Works Seattle Inc.
Geering Broach & Spline Inc.
Gene Bell Chevrolet
General Aviation Manufacturers Association
General Birch Service Corp.
General Broach & Engineers Co.
General Cable Co.
General Cinema Corp.
General Drafting
General Dynamics Corp.
General Electric Co.
General Foods Corp.
General Host Corp.
General Instrument Corp.
General Mills Inc.
General Motors Corporation
General Products Corp.
General Signal Corp.
General Tire and Rubber Company
General Tobacco Candy Co.
Genesco Inc.
George A. Cenkner
George A. Hormel & Co.
George A. Jerry Co.
George Washington Hospital
Georgia-Carolina Oil Co.
Georgia Coated Fabrics Co.
Georgia-Pacific Corp.
Gerber Products Co.
Gerlinger Industries Corp.
Gerson & Gerson Inc.
Getty Oil Co.
Giant Food, Inc.
Gibson Coal Co. Inc.
Gillette Co.
Glandorf Tile Co.
Glass Container Council of Canada
Glasson Inc.
Glass Packaging Institute
Glenn L. Haught & Sons
Glenn Machine & Welding Co.
G. L. Sayles Inc.

Goforth Industries, Inc.
Golden Belt Telephone Association Inc.
Gold Kist Inc.
G. O. Nitzsche Sons
Good Chevrolet Motors
Good-Life Chemicals Inc.
Good Housekeeping Magazine
Goodyear Tire & Rubber Co.
Gordon Bartels Co. Inc.
Gould Inc.
Government of Australia
    Australian Metric Conversion Board
    Embassy of Australia
Government of Canada
    Department of Consumer and Corporate Affairs
    Embassy of Canada
    Metric Commission Canada
    Standards Council of Canada
G. P. Lachicotte
Graco Fertilizer Co.
Grand Rapids Forging & Steel Co.
Graphic Metals Inc.
Great Atlantic & Pacific Tea Company
Great Lakes Sales Inc.
Great Northern Distributors
Great Western United Corp.
Green Brothers Gravel Co. Inc.
Green Giant Co.
Greenville News Inc.
Greyhound Corp.
Grocery Manufacturers of America, Inc.
Grocery Products Manufacturers Association of Canada
Groov Pin Corp.
Grosseurth Distillers Inc.
Groth Chevrolet Co.
Grumman Corp.
Grundy National Bank (IA)
Guarantee Iron Works
Guide for Religious Architecture
Guild Wineries & Distilleries
Gulf Oil Corp.
Gulf & Western Industries
Gustafron Ice Cream - Dairy Co.
Gust G. Larson & Sons Inc.
Gypsum Association
Gypsum Drywall Contractors International
Hackensack Specialty
Hallcraft Inc.
Hamilton Lumber Veneer

ANNEX I

Hammermill Paper Co.
Hand Tool Institute
Handy & Horman
Hanes Corp.
Hanna Mining Co.
Hanna Paint Manufacturing Co.
Hanson Scale Co.
Harbison & Mahony
Hardings Three Rivers Markets
Hardwood Dimension Manufacturers Association
Hardwood Plywood Manufacturers Association
Hardwood Research Council
Harnischfeger Corp.
Harper & Bowers Inc.
Harris Corp.
Harris & Frank Inc.
Harsco Corp.
Hartley Gove Sons
Hart, Schaffner, & Marx
Harvey Cadillac Co. Inc.
Hauser Chevrolet Co. Inc.
Hawkridge Brothers Co. Inc.
Hayes Brothers Inc.
Health Industry Manufacturers Association
Hechingers, Inc.
Heil Equipment Philadelphia
Hendrix Wire & Cable Corp.
Henry Co.
Henry F. Ortlieb Brewing Co.
Henry Myer Thread Manufacturing Co.
Henry Schein Inc.
Heppner Iron & Metal
Herbert Curtin Co. Inc.
Hercules Inc.
Heritase Store Inc.
Herman Market Co.
Hershey Brothers
Hershey Foods Corp.
Herzog & Co. Inc.
Hesse Envelope Co.
Hetzel-King Association Inc.
Heublein Inc.
Hewlett-Packard Co.
Highland Manufacturing Co.
Highland Supply Corp.
Highway Users Federation for Safety and Mobility
Hilander Foods Inc.
Hill Box Co. Inc.
Hill Brothers & Co.
Hilton Packing Corp.

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Hines Liner Co. Inc.
Hi-Ram Inc.
Hiram Walker, Inc.
Hi-Shear Corp.
H. J. Fuller & Sons, Inc.
H. J. Heinz Co.
H. K. Porter Co.
H.M.C. Associates
Hobart Corp.
Hobby Center Inc.
Hoerner Waldorf Corp.
Hoffman-Cortes Contracting
Hofler Seed Co.
Holiday Carpet Co. Inc.
Holiday Hosiery, Mills Inc.
Home Economics Education Association
Home Oldsmobile
Homer E. Wright, Jr.
Honeywell, Inc.
Hoover Ball & Bearing Co.
Hoover Co.
Hopeman Equipment Co. Inc.
Horedaille Industries
Horspool & Romine Manufacturing Co.
Horta-Craft Corp.
Houston Grinding & Manufacturing Co.
Howard Lumber Company
Howard Lumber & Kiln Co.
Howell and Company
H. P. Hood Inc.
H. S. Ostlin Co.
H. S. Sowards & Sons Inc.
Hubert M. Bilton
Hubler Brothers
Hub Oil Co. Inc.
Hudson Supply & Equipment Co.
Huebner Supply Co.
Hughes Aircraft Company
Hughes Tool Co.
Humboldt Brick & Tile Co.
Humphrey Auto Lease Inc.
Huser-Paul Co. Inc.
Hyde Park Lumber Co.
Hydraulic Accessories
Hygrade Food Products Corp.
Hyster Co.
IBP Equipment Corp.
IC Industries
Identicon Corp.
Idle Wild Foods

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I. Lehrhoff & Co. Inc.
Illinois F.W.D. Trucks Co.
Illuminating Engineering Society of North America
Impact Label Corp.
IMPCO Inc.
Imperial Oil of Canada (Exxon)
Imported Hardwood Products Association
Indiana Carton Co. Inc.
Indiana Cash Drawer Co.
Indiana Limestone Institute
Indian Head Inc.
Industrial Engineering Equipment
Industrial Fastener Institute
Industrial Heating Equipment Association
Industrial Machine Co.
Industrial Refrigeration-Equipment
Industrial Roofing Co. Inc.
Ingersoll Rand Co.
Ingersoll Milling Machine Co.
Inland Container Corp.
Inland Products Inc.
Inland Steel Company
Inmont Corp.
Inshield Die & Stamping Co.
Insilco Corp.
Instantwhip - Cincinnati
Institute of Business Designers
Institute of Electrical and Electronics Engineers, Inc.
Institute of Real Estate Management
Interco Inc.
Interlake Inc.
Intermountain Equipment Rental
International Air Transport Association
International Association for Housing Sciences
International Association of Electrical Inspectors
International Association of Machinists
International Association of Marble, Slate and Stone Polishers Workers' Helpers
International Association of Plumbing and Mechanical Officials
International Association of Wall and Ceiling Contractors
International Bank (TX)
International Brotherhood of Electrical Workers
International Brotherhood of Painters and Allied Trades
International Builders Exchange Executives
International Business Machines Corp.
International Civil Aviation Organization
International Conference of Building Officials
International Council of Shopping Centers
International District Heating Association

International Fence Industry Association
International Grooving and Grinding Association
International Harvester Co.
International Importers Inc.
International Masonry Institute
International Minerals & Chemical
International Multifoods Corp.
International Paper Co.
International Systems & Controls Corp.
International Telephone & Telegraph
Interstate Brands Corp.
Invo-Saline Inc.
Iowa Beef Processors Inc.
Iowa Savings Bank
Irvin Enterprises Inc.
Irwin - Harrisons - Whitney Inc.
Irwin Hodson Company
Irwin Steel Co.
Isanti County Co-op Association
Israel Transfer Co. Inc.
Itel Corporation
Jack B. Kelley
Jackies Smartwear Inc.
Jack Marshall Lincoln Mercury
Jackson Cookie Co. Inc.
J. Adams & Co. Inc.
J. A. Fulmer & Son
James Brudnick Co. Inc.
James Walker Co.
J. A. M. Taylor Tool Co., Ltd.
Janesville State Bank (MN)
Japan Trade Center
Jay Kline Chevrolet Co.
Jay Products Company
J. B. Pfister Co. Inc.
J. B. Ruderman & Sons Inc.
J-B-T Instruments Inc.
J. C. Penney Company, Inc.
J. C. Procter Company
Jenkins Equipment
Jenkins Gin Co.
Jenkins Publishing Co.
Jeppesen-Sanderson
Jerome Duncan Ford, Inc.
Jesse Jones Box Corp.
Jim Walter Corp.
J. J. Henry Co.
J. J. Nichting Co. Inc.

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J. Kathy Inc.
Jo Daviess Service Co.
Joe Bokman Chevrolet Dealership
Johnathan Logan Inc.
John E. Rogers Inc.
John F. Humphrey Metal Fabrication
John Hassall, Inc.
John Helfrich Trucking Co.
John P. Nissen Jr. Co.
John Seven Paint & Wallpaper
Johns-Manville Corp.
Johnson & Johnson
John Unertl Optical
John W. Daniels Paving Co.
Jones & Laughlin Steel Service Center
Jones Oil Co.
Joseph D. Withrow
Joseph E. Seagram & Sons Inc.
Joseph M. Feldman Inc.
Joseph Ruzicka South Inc.
Joseph Schlitz Brewing co.
Joseph T. Ryerson and Son, Inc.
Joy Manufacturing Co.
J. P. Stevens Co. Inc.
Jr. Row Inc.
J. Rubin & Co. Inc.
J. S. West & Company
Kaiser Aluminum & Chemical Corp.
Kaiser Industries
Kal Equipment Co.
Kane Miller Corp.
Kansas State University
K. A. Pridjian & Co.
Karen Frocks Inc.
Kar Go Service Center Charlotte Inc.
Karnes County National Bank (TX)
Kasper Manufacturing Company
Kasser Distillery, Inc.
Keelor Steel Inc.
Kelley Electric Company
Kellogg Co.
Kellwood Co.
Kennecott Copper Corp.
Kenney Machinery Corp.
Kentucky Manufacturing Co.
Kentucky State Bank
Kerr-McGee Corp.
Kewanee Industries Inc.
Keyes Machine Works Inc.

Keystone Prestone Bakery Inc.
Kimberly-Clark Corp.
King County Directors Association (WA)
Klingensmith Hardware Inc.
Kloster Research and Development Inc.
K. M. Biggs Tractor Sales Inc.
Knight-Ridder Newspapers, Inc.
Knitting Mills Inc.
Koehring Co.
Kolb - Lena Cheese Co. Inc.
Koppers Co., Inc.
Korwall Industries Inc.
Koury Construction Inc.
Kraftco Corp.
Kramer Service Inc.
Kresge SS Co.
Kretschmer Tredway Co.
K-Tron Corp.
Kwik Kopy Center No 41
LA Belle Manufacturing Corp.
Lacchi Construction Co. Inc.
Lakeside Development Co.
Lakeside Fusee Corp.
Lake Wausau Granite Co.
Lamson and Sessions
Land O'Lakes Inc.
Landstrom Gravel Co.
Lane Sales Pepsi
Lasham Cartage Co.
Latchford Glass Company
Latrobe Brewing
Lawrence Broom & Mop Co. Inc.
Lawrence Institute of Technology
Lazy a Ranch
L. Deardorff & Sons Inc.
Leachville State Bank (AR)
Lead Industries Association
Lear Siegler Inc.
Leep Homes, a California Corp.
Le Fiell Manufacturing Co.
Lehmans Garage
Leo Froelich
Leslie Haley & Son Inc.
Letty Lane Company Inc.
Lever Brothers Co.
Levin & Co. Inc.
Levi Strauss & Co.
Lexbon Enterprises Inc.
Libbey - Owens - Ford Co.
Libby McNeill & Libby

Libertyville Lumber Co.
Liggett Group, Inc.
Lightning Protection Co.
Lightweight Aggregate Producers Association
Linder Furniture Co. Inc.
Lindsey Oil Co. Inc.
Little Crow Milling Co.
Litton Fastening System
Litton Industries Inc.
Lively Look Sportswear Inc.
L & L Distributing Co.
L & L Manufacturing Co.
L & L Tool Company
Locke-Ober Co.
Lockheed Aircraft Corp.
Loeser & Sons Inc.
Lone Star Industries Inc.
Loomis Farmers Co-op Co.
Loomtogs Inc.
Los Angeles Brush Manufacturing
Lou Harris & Associates, Inc.
Louis "J" Sportswear Inc.
Louisiana Land & Exploration Co.
Louisiana - Pacific Corp.
Louisiana Tech University
Lowrance Electronics Inc.
Lowe Electric Co, Inc.
LTV Corp.
Lubbock Poster Co.
Lubrizol Corp.
Ludell Manufacturing Co.
L. - W. Service Co.
Lykes Corporation
Lyon County Co-op Oil Co.
Mabry Mill Works Inc.
Mack Sales Inc.
Macmillan, Inc.
Macoy Publishing and Masonic Supply Co.
Mac Rae Tool Co.
Maddox and Associates
Magline Inc.
Maiers Motor Freight Co.
Maillards Inc.
Mainline Sales Co. Inc.
Makall Tool Co, Inc.
Malcolm's Wholesale Meats Inc.
Mallin Imports Inc.

Malphrus Construction Co. Inc.
Manco Tooling Inc.
Mandish Plastics
Manhattan Industries, Inc.
Mansfield Tire and Rubber Co.
Manufacturer of Illumination Products
~~MAPCO Inc.~~
Maple Flooring Manufacturers Association
Marathon Oil Co.
Marble Institute of America
Marcus Paint Company Inc.
Marfry Inc.
Markman Peat Co. Inc.
Markel Electrical Product
Mark Hurd Aerial Surveys, Inc.
Marsh Lumber Co. Inc.
Martindell Molding Co.
Martin & Herring Inc.
Martin Marrietta Corp.
Martin Sale-Service Inc.
Mary Barbuzanes
Masco Corp.
Mascoutah Grain & Feed Co.
Mason Contractors Association of America
Masonite Corp.
Massey-Ferguson Industries Ltd.
Mastercraft Furniture Co.
Mather & Sons Inc.
Mathis Grain & Elevator Corp.
Matsushita Electric
Mattel Inc.
Maury Fence Company
Max Silverstein & Son Inc.
Max Werner Fruit & Vegetable
Mayhill Publications Inc.
Mayo Knitting Mill Inc.
Mays Merchandise Co.
M. Blaustein Inc.
McAnary Ford Inc.
MCA Inc.
McCall Chair Co. Inc.
McDonald Corporation
McDonnell-Douglas Corporation
McGraw-Edison Co.
McGraw-Hill, Inc.
M. C. Hall Dairy
McCook Electric Co-op
McKay Cadillac, Inc.
McLeod Enterprises Inc.
McLouth Steel Corporation

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McNeil Laboratories, Inc.
Mead Corp.
Meadowbrook Dairy
Means Stamping Co.
Meadtex Fabrics Co. Inc.
Mechanical Contractors Association of America
Meehan Steel Products Co.
Memorex Corp.
Menco Products
Merck & Co. Inc.
Merco Manufacturing Inc.
Meridian Lanes Inc.
Meskin & Davis Inc.
Meson Electric Co. Inc.
Metal Building Manufacturers Association
Metal Lath Association
Met-L-Wood Corp.
Metrication Board of Zambia
Metro Park Tire Centers
Metz Shopping Center
Michaels Art Bronze Co.
Michelin Tire Company
Michigan Livestock Exchange
Michigan Screw Products
Micro Craft Inc.
Microx Corporation
Mictron Inc.
Midland-Ross Corp.
Mid-State Telephone Co.
Midway Volkswagen Inc.
Midwest Products & Manufacturing
Milan Screw Products
Miles Laboratories
Milk Industry Foundation
Miller Brewing Company
Milner Chevrolet Co. Inc.
Milsco Manufacturing Co.
Milton S. Kronheim & Co., Inc.
Milwaukee Brush Manufacturing Co.
Minnesota Mining & Manufacturing Co.
Miss Capri Sportswear Inc.
Mitchell Electric Co.
M. Lee Goldsmith Inc.
M. Lowenstein & Sons, Inc.
Mobile Home Dealers Association
Mobile Oil Corp.
Mockwitz Construction Co.
Modern Chevrolet Co.
Modern Gas Co. Inc.
Mohasco Corp.

Mokena State Bank (IL)
Moles-The
Monarch Manufacturing Works Inc.
Monarch Tool Gauge
Monarch Wine Co. Inc.
Mondavi Winery
Monfort of Colorado Inc.
Monroe County Electric Co-op
Monsanto Co.
Montgomery County (MD) Department of Liquor Control
Montgomery Wards
Moore Iron Works
Moores Potato Chip Co.
Morgan & Culpepper Inc.
Mortgage Bankers Association of America
Morton-Norwich Products Inc.
Mosheim Bank (TN)
Mossberg & Co., Inc.
Moss Trucking Co., Inc.
Motorola Inc.
Motor Vehicle Manufacturers Association
Motor Wheel Corp.
Mount Ayr Record-News
Mr. Aircraft Inc.
~~M. Silverman Laces Inc.~~
M & S Manufacturing Company
Muir, Wilson & Muir
Multi Products Inc.
Munsingwear
Murphy Oil Corp.
Mynol Inc.
Nabisco Inc.
Nalco Chemical Co.
Narragansett Lumber Co.
Nashua Corp.
Nashville State Bank (IN)
Nassau Bay National Bank (TX)
Nathan Miller
National Alcoholic Beverage Association, Inc.
National Apartment Association
National Asphalt Pavement Association
National Association of Architectural Metal Manufacturers
National Association of Building Manufacturers
National Association of Brick Distributors
National Association of Decorative Architect Finish
National Association of Demolition Contractors
National Association of Elevator Contractors
National Association of Home Builders
National Association of Housing Cooperatives
National Association of Independent Fee Appraisers
National Association of Independent Insurers

National Association of Independent Lumbermen
National Association of Industrial Parks
National Association of Lighting Maintenance Contractors
National Association of Miscellaneous
Ornamental, & Architectural Products Contractors
National Association of Motor Bus Owners
National Association of Plastic Fabricators
Plastic Pipe Institute
National Association of Plastics Distributor
National Association of Plumbing, Heating, &
Cooling Contractors
National Association of Real Estate Appraisers
National Association of Real Estate Investment Trust
National Association of Realtors
National Association of Reinforcing Steel Contractors
National Association of Steel Pipe Distributors
National Association of Stone Fixture Manufacturers
National Association of Women in Construction
National Auto Dealers Association
National Automatic Sprinkler & Fire Control Association
National Bark Sales
National Board of Boiler & Pressure Vessel Inspectors
National Builders Hardware Association
National Building Materials Distributors Association
National Can Corp.
National Cash Register
National Cellulose Insulation Manufacturers Association
National Clay Pipe Institute
National Collegiate Athletic Association
National Committee on Uniform Traffic Laws and Ordinances
National Concrete Masonry Association
National Concrete Paving Association
National Conference of State Legislatures
National Conference of States on Building Codes & Standards
National Conference on Weights and Measures
National Construction Industry Council
National Constructors Association
National Corrugated Steel Pipe Association
National Council of Accoustical Consultants
National Council of Farmers Coops
National Council of Teachers of Mathematics
National Crushed Stone Association
National Dairy Council of Canada
National Distillers & Chemical
National Distillers Products Co.
National Education Association
National Electrical Contractors Association
National Elevator Industry, Inc.
National Environmental Systems Contractors Association
National Federation of Independent Businesses
National Federation of State High School Associations

National Fire Protection Association
National Flag Co.
National Flexible Package Institute
National Fluid Power Association
National Forest Products Association
National Frame Builders Association
National Frozen Food Association
National Geographic Society
National Governor's Conference
National Gypsum Co.
National Hardwood Lumber Association
National Home Improvement Council
National Institute of Automotive Service Excellence
National Institute of Building Sciences
National Institute of Education
National Insulation Contractors Association
National Kitchen Cabinet Association
National Landscape Association
National Locksmith Suppliers Association
National Limestone Institute
National Lumber & Building Materials Dealers Association
National Lumber Exporters Association
National Machine Tool Builders Association
National Milk Producers Federation
National Mineral Wool Insulation Association
National Oak Flooring Manufacturing Association
National Oil Fuel Institute
National Paint and Coatings Association
National Particleboard Association
National Precast Concrete Association
National Quartz Producers Council
National Ready Mixed Concrete Association
National Retail Merchants Association
National Rifle Association
National Roofing Contractors Association
National Sand and Gravel Association
National Sash and Door Jobbers Association
National Scale Men's Association
National Screw Products Co.
National Service Industries
National Slag Association
National Small Business Association
National Society of Professional Engineers
National Soft Drink Association
National Starch and Chemical Corp.
National Steel Corp.
National Steel Erectors Association, Inc.
National Stellar Co.
National Terrazzo and Mosaic Association
National Tool, Die, and Machinery Association

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National Utility Contractors Association
National Wholesale Hardware Association
National Wholesale Lumber Distributing Yard Association
National Woodwork Manufacturers Association
Natomas Company
Natural Rubber Shippers Association
Nebraska - Iowa Supply Co. Inc.
Neely Manufacturing Co. Inc.
Nehi Bottling Company (TX)
Nehi-Dr. Pepper Bottling Co. (OK)
NE Lumber Manufacturers Association
Nemaha County Co-op Association
New Britain Spring Co.
New England Converters Inc.
Newmont Mining Corp.
New York City Department of Consumer Affairs
New York Times Co.
New Zealand Metric Advisory Board
Nic-Nae Grill
Nic-O-Loc Co.
N L Industries, Inc.
N. L. Kuehn Company
Norin Corp.
Norris Industries
Norris Rees
North American Knitting Co.
North American Philips Corp.
North American Wholesale Hardware Association
Northeastern Loggers Association
Northeastern Retail Lumbermen's Association
Northern Hardwood & Pine Manufacturing Association
Northrop Corporation
Northrup King Seed Co.
Northwestern Lumbermen, Inc.
Northwest Industries Inc.
Northwest Pattern
North Wind Power Company Inc.
Norton Co.
Norton Simon Inc.
NVF Co. Inc.
Oaksdale Grain Growers Inc.
Occidental Petroleum
Oehlert Brothers, Inc.
Ogden Corp.
Ohaus Scale Corp.
Ohio Nut & Washer Co.
O. K. Auto Parts
Old Dominion Coal Corp.
Olin Corp.
Olinkraft Inc.

Olympic Foundry Co.
Operative Plasters and Cement Masons International
  Association of the United States and Canada
Opie Brush Co. Inc.
Opinion Research Corp.
~~Orange Buick Co.~~
Oregon Brass Works Inc.
Oro Manufacturing Company
Orville D. Thompson
Oscar Mayer & Co. Inc.
Osterbauer Compressor Service
Otto Hofmann & Sons
Outdoor Marine Corp.
Owens-Corning Fiberglass Corp.
Owens Illinois Inc.
Oxmoor House, Inc.
Pabst Brewing Co.
Paccar Inc.
Pacific Cold Storage Inc.
Pacific Logging Congress
Pacific Lumber Exporters Association
Pacific Lumber Inspection Bureau
Pacific Westbound Shipping Conference
Packaging Associates Inc.
Pacolite Plastic, Inc.
Page Plumbing & Heating Co.
Paley Office Supply Co.
Pan American World Airways
Panhandle Construction Co.
Parker-Hannifin Corp.
Park Lane Furniture Inc.
Par-Kut International Inc.
Parsons Casket Hardware Co.
Paternayan Brothers Inc.
Paty's Inc.
Paul Goorin
Peabody Coal Co.
Peabody House Inc.
Peabody International Inc.
Pearson's Liquor and Wine Annex
Peavey Corp.
Peerless Sportswear Co. Inc.
Penn Needle Art Co. Inc.
Pennsylvania State University
Pennwalt Corp.
Pennzoil Co.
Peoples Bank (GA)
Peoples Banking Co. (OH)
Peoples National Bank (IL)

Peoples State Bank (IL)
Peoples State Bank (MN)
Pepsi Co., Inc.
Pepsi Cola Bottling Co. (KS)
Pepsi Cola Bottling Co. (MD)
Perkin-Elmer Corp.
Pet
Pfizer Inc.
Pharmaceutical Manufacturers Association
Phelps Dodge Corp.
Philip Morris, Inc.
Phillipine Mahogany Association
Phillips Ford Inc.
Phillips Petroleum Co.
Picketts Food Service Inc.
Pierce Avery Corp.
Pillsbury Co.
Pine Cone Lumber Co. Inc.
Pioneer National Bank (WI)
Pipe Fabrication Institute
Pitney Bowes, Inc.
Pittsburg Brewing
Pittsburg Plate Glass Industries, Inc.
Pittson Co.
Plastics in Construction Council
P. L. Robertson, Manufacturing
Plumbing & Drainage Institute
Plywood Research Foundation
Plywood Supply Inc.
Pohlig Brothers Inc.
Polaroid Corp.
Ponsford Brothers Contractors
Poole-Dickie Lumber Co.
Popi Fashions Inc.
Portage National Bank (IN)
Portland Cement Association
Potlatch Corp.
Power and Communication Contractors Association
Pratt Poster Co. Inc.
Precision Fabricating & Manufacturing
Precision Instruments
Precision Steel Warehouse
Premium Products, Inc.
Preskill Lumber Co.
Prestressed Concrete Institute
Preway Inc.
Pribble Plastic Products
Printing Industries of America
Proctor & Gamble Co.
Proctor Products

Products Filling & Packaging
Professional Golf Association
Proprietary Association
Pryor Oldsmobile Co.
Puerto Rico
Department of Education
Pulaski Rubber Co.
Purdue University
Purex Corp. Ltd.
Puritan Fashions
Quaker Oats Co.
Quaker State Oil Refining Corp.
Quality Boiler & Machine Works
Qualtek Inc.
Questar Corp.
Questor Corp.
Quick Industries Inc.
Radio Parts Co.
Rainy Day Foods
Raja Development Co. Inc.
Rajala Mill Co.
Rakows Town-Country
Ralston Purina Co.
Ram Meter Inc.
Rand-McNally
Ransome Co.
Rappel and Hoeing Co. Inc.
Rath Packing Co.
Ratrie Robbins-Schweizer Inc.
Ravarino & Freschi, Inc.
Rawdon Brothers Aircraft, Inc.
Raynal Plymouth Co.
Raytheon Co.
RCA
R. D. Mann Carpet Co. Inc.
R. & D. Plastics, Inc.
Ready Mixed Concrete Co.
Real Estate Securities and Syndication Institute
Realtors National Marketing Institute
Red Seal Electric
Reeves Sheet Metal
Refrigerating Engineers and Technicians Association
Regal-Beloit Corporation
Reichhold Chemicals Inc.
Reinforced Concrete Research Council
Reliable Contracting Co. Inc.
Reliable Packaging Inc.
Reliance Electric Co.
Reliance Steel Corp.
Remco Maintenance Corp.

Renken Boat Manufacturing Co., Inc.
Renmuth, Inc.
Republic Steel Corp.
Resco Products Inc.
Resilient Tile Institute
Retail Council of Canada
Revere Copper & Brass Inc.
Revlon Inc.
Rexnord, Inc.
Rex Roto Corp.
Reynolds Metals Co.
R. F. Thompson Grain Co.
Rhapsoay Blouse & Sportswear
Rice Lake Farmers United Co-op.
Richard C. Greene
Richards Brick Company
Richardson-Merrell, Inc.
Richling Ades & Richman Inc.
Rich Oil Co.
Riney Construction Co.
Riverlands National Bank (LA)
R. J. Reynolds Industries
Robinson Steel Co.
Rocco V. D. Andrea
Rockford Brick-Tile Co.
Rockford Products
Rock River Manufacturing Corp.
Rockwell International Corp.
Roethele Building Materials
Rohm & Haas Co.
Rohr Industries Inc.
Ronconi Equipment Co. Inc.
Roper Corp.
Roper Organization, Inc.
Rose City Press Inc.
Rossoe, Inc.
Royston Laboratories Inc.
R. R. Donnelly & Sons, Co.
RSE Inc.
Rubber Manufacturers Association
Running Supply Inc.
Russell and Company
Russ Togs, Inc.
Rutgers State University
Safety Check Alignment and Brake Service
Safe-T-Mate
Safeway Stores Incorporated
Safeway Tire Company
Saffer Springs Grain Co.

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Saginaw Creamery Co.
Saginaw Processing & Supply Co.
St. Alban Co-op Creamery
St. Joe Minerals Corp.
~~St. Mary's State Bank (GA)~~
St. Reses Paper Co.
Salem Bank (KY)
Salvatore Bruzzese
Samuel Cabot Paint and Stains
Samuel M. Gertman Co. Inc.
Sanborn Savings Bank (IA)
Sanjo Dress Inc.
Saul Brothers & Co.
Saxon Industries, Inc.
Scale Manufacturers Association
Schachner Belt Company
Schering Plough Corp.
Schlueter Manufacturing Co.
Schmidt Company
Schooner Corp.
Schwarz Fish Company
SCM Corp.
Scoggin-Dickey Buick Co.
Scott & Fetzer
Scott Paper Co.
Scovill Manufacturing Co.
Scranton Building Block Co.
Screen Manufacturers Association
Scripps Foundry-Machine Works
Sears Roebuck & Co.
Seaway Bolt & Specials Co.
Security Bank (ND)
Security Savings Bank (IA)
Security State Bank (MO)
S. Edwards Inc.
Sekan Cheese Co.
Selby, Battershy & Company
Serta Restokraft Mattress
Service Erection & Machine
Sethness Products Co.
Seven-Up Company
S. F. Sherard & Sons Inc.
S. G. Taylor Chain Co.
Shanes Marine & Hardware
Shasta Beverages
Shattuck National Bank (OK)
Shawn Originals Inc.
Sheffield Furniture Corp.

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Sheller Globe Corp.
Shell Oil Co.
Shepher Distributors-Sales
Sherwin-Williams Co.
Sherwood Industries
Shramsberg Champagne
Shuberts Ice Cream & Candy
Sidney Rothschild Inc.
Siegels Sixth St. Supermarket
Signal Companies, Inc.
Signal Hills State Bank (MN)
Signode Corp.
SI Handling Systems Inc.
Silver Loaf Baking Co.
Simmons Co.
Simplicity Patterns Co.
Singer Co.
Singer Products Co. Inc.
S. J. Carlson & Son Inc.
Sklar Manufacturing Co. Inc.
Skyline Bel Air Estates Inc.
S. L. Industry
Slocomb Plastic Pipe & Products Inc.
Smaller Business of America
Smith Cookie Co.
SmithKlene Corp.
Smith Specialty Co.
Smith-Willison Inc.
S. M. Jones & Co. Inc.
Snodgrass-Maner Co.
Society Brands Limited
Society of American Registered Architects
Society of American Wood Preservers
Society of Automotive Engineers
Society of Construction Superintendents
Society of Exchange Counselors
Society of Industrial Realtors
Society of Manufacturing Engineers
Society of Plastics Engineers
Society of Real Estate Appraisers
Society of the Golden Section
Society of the Plastics Industry
Society of Turkish Architects, Engineers, and
  Scientists in America
Somerset Telephone Co.
Soniform, Inc.
Sound Shop
Sou Pump & Tank Company
South African Bureau of Standards

Southeastern Lumber Manufacturers Association
Southern Forest Products Association
Southern Hardwood Lumber Manufacturers Association
Southern Pine Inspection Bureau
Southern Pressure Treaters Association
Southern Sash Supply Montgomery,
Southern Wholesalers Association
Southern Woodwork Association
Southwestern Stationary-Bank Supply
Southwest Forest Industries
Southwest Recyclers Inc.
Space & Leisure Time Ltd.
Space-Links Inc.
Spartanburg Lumber-Millwork
Spartanics Ltd.
Specialties Wrought Iron
Spencer Foods Inc.
Sperry & Hutchinson
Sperry Rand Corp.
Springfield Aluminum & Brass
Springfield Instrument
Springs Mills Inc.
Square D Co.
Squibb Corp.
S. R. M. Motel Corp.
Staal Buick Inc.
Staflex Co.
Stained Glass Association of America
Standard Brands Inc.
Standard Cycle Co.-Inc.
Standard Modern Tool Co., Ltd.
Standard Oil of California
Standard Oil Co. (Indiana)
Standard Oil Co. (Ohio)
Standard Venetian Blind Co.
Standco Industries, Inc.
Stanley Drug Products Inc.
Stanley Works
Stanton Steel Company
Stardust Motel Inc.
Star Headlight & Lantern Co.
Starr Electric Co.
State Bank (IL)
State Bank (MN)
State Bank (WI)
State governments and agencies:
Alabama
Department of Education
Alaska
Department of Commerce and Economic Development
Department of Education

ANNEX I

Arizona
- Department of Agriculture
- Department of Education

Arkansas
- Department of Commerce
- Department of Education

California
- Department of Consumer Affairs
- Department of Education
- Department of Food and Agriculture
- Department of General Services
- Department of Health
- Department of Motor Vehicles
- Department of Transportation
- Division of Measurement Standards
- General Assembly Agriculture Committee
- Highway Patrol

Colorado
- Department of Education
- Department of Highways

Connecticut
- Department of Education
- Department of Transportation

Delware
- Department of Public Instruction

Florida
- Department of Education

Georgia
- Department of Education
- Department of Transportation
- Metrication Commission

Hawaii
- Department of Education
- Division of Weights and Measures

Idaho
- Department of Education

Illinois
- Office of Education

Indiana
- Department of Education

Iowa
- Department of Public Instruction

Kansas
- Board of Agriculture
- Department of Education

Kentucky
- Department of Education

Louisiana
- Department of Agriculture
- Department of Education
- Legislative Council

Maine
- Department of Education

Maryland
- Department of Education
- Department of General Services
- Department of Liquor Control
- Highway Commission

Massachusetts
- Department of Education
- Division of Standards

Michigan
- Department of Education

Minnesota
- Department of Education
- Metric Council

Mississippi
- Consumer Protection Division
- Department of Education

Missouri
- Department of Agriculture
- Department of Education

Montana
- Department of Education
- Division of Business Regulations

Nebraska
- Department of Agriculture
- Department of Education

Nevada
- Department of Commerce
- Department of Education

New Hampshire
- Department of Education
- Department of Purchase and Property

New Jersey
- Department of Education

New Mexico
- Department of Education

New York
- Bureau of Weights and Measures
- Department of Agriculture and Markets
- Department of Education

North Carolina
- Department of Administration
- Department of Public Education

North Dakota
- Department of Public Instruction

ANNEX I

Ohio
Bureau of Weights and Measures
Department of Administrative Services
Department of Agriculture
Department of Education
Department of Liquor Control
Department of Transportation
Oklahoma
Department of Education
Department of Transportation
Oregon
Department of Agriculture
Department of Education
Pennsylvania
Department of Agriculture
Department of Commerce
Department of Education
Department of Environmental Resources
Department of General Services
Department of Labor and Industry
Department of Transportation
Liquor Control Board
Turnpike Commission
Rhode Island
Bureau of Weights and Measures
Department of Education
South Carolina
Department of Education
South Dakota
Department of Education
Tennessee
Department of Agriculture
Department of Education
Texas
Department of Agriculture--Consumer Services
Department of Education
Utah
Department of Education
Vermont
Department of Education
State Planning Office
Virginia
Department of Education
Washington
Superintendent of Public Instruction
West Virginia
Department of Education
Department of Labor
Division of Consumer Products

Wisconsin
Department of Agriculture
Department of Public Instruction
Wyoming
Department of Education
State Savings Bank (MI)
State University of New York-Buffalo
State Wholesale Food Inc.
Stauffer Chemical Co.
Stedman Hosiery Mills Newton
Steel Company of Canada
Steel Deck Institute
Steel Door Institute.
Steel Forgings Inc.
Steel Service Center Institute
Steel Supply Co.
Steel Window Institute
Stellar Manufacturing Co.
Stephenson Lithograph Inc.
Sterling-Clark Lurton Corp.
Sterling Drug Inc.
Sterling Outdoor Advertising Co.
Stokely-Van Camp, Inc.
Stokes Fish Co.
Stolper Industries Inc.
Stor Dor Freight System Inc.
Straford Chemical Co.
Strauss Plastic Co., Inc.
Striegel, Inc.
Strohecker Inc.
Strouse Adler Co.
Strouse & Brothers Inc.
Structural Engineers Association of California
Structural Products, Inc.
Stucco Manufacturers Association
Studebaker-Worthington Inc.
Sudlersville Bank of Maryland
Sugar Land Telephone Co. Inc.
Sunbeam Corp.
Sun-Maid Raisin Growers of California
Sun Petroleum Products Company
Sunstrand Corp.
Superior Oil Co.
Supreme Dairy Products Co.
Susan Page Inc.
Sutherland Farmers Co-op Co.
Sutter Products Co.
Sutton Tool Company
S. Vogel Sons Inc.
Swink Hosiery Mill Inc.

ANNEX I

Sybron Corp.
Syncro Corporation
Taconic Manufacturing & Tool Corp.
Talanco Motors Inc.
Talley Industries Inc.
Tarheel Electric Supply Inc.
Taylor Provision Co. Inc.
Teamsters Union
Tecumseh Products Co.
Technical Research Co.
Teen Colony Inc.
Teknicote Inc.
Tektronix, Inc.
Teledyne Inc.
Tenneco Inc.
Tersco Inc. of West Texas
Tesoro Petroleum Co.
Texaco Inc.
Texasgulf Inc.
Texas Instruments
Textron, Inc.
Thermal Insulation Manufacturers Association
Thermo Conductor Services
Thermopatch Corp.
Thiesing Veneer Co.
Thiokol Chemical Corp.
Thomasboro Grain Co.
Thomas J. Lipton Inc.
Thompson Concrete Products
Thorrez Industries Inc.
Thurman Scale Co.
Timber Producers Association of Michigan & Wisconsin
Time Inc.
Times Mirror Co.
Timken Co.
Timmerman Construction Inc.
Tiny Toron Togs Inc.
Tire and Rim Association
Tire Industry Safety Council
Toledo Scale Company
TOSCO Corp.
Town & Country Custom Fixtures
Towncraft Inc.
Trane Co.
Transport Storage-Distributing Co.
Trans Union Corp.
Trans World Airlines, Inc.
Trend Industries, Inc.
T. R. Heard Inc.
Tribune - Star Publishing Co.

Tri-City Fabricating & Welding Co.
Tri-County Electric Association
Truck Cab Manufacturers Inc.
Truck & Trailer Sales Corp.
Truckers Equipment Inc.
TRW Inc.
Traffic & Transport Inc.
Trailer Coach Association
Triangle Manufacturing Co.
Truman Boyles Mattress Co. Limited
Truss Plate Institute
Tufts and Wenzel Architects
Tufts New England Medical Center
Tunis Manufacturing Corp.
Turner & Allen Chemical Co.
Twentieth Century - Fox Film Corp.
Twentieth Century Heating Co.
Twin Island Motel Inc.
Tyler Corp.
Underground Engineers Contractors Association
Underwriters Laboratories, Inc.
Union Carbide
Union Oil Company of California
Union - Whitten State Savings Bank (IA)
Uniroyal Tire Company
United Airlines
United Aluminum Corporation
United Association of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry
United Auto Workers
United Brands Co.
United Brotherhood of Carpenters and Joiners of America
United Bus Owners Association
United Camp Corp.
United Cement, Lime & Gypsum Workers International Union
United Merchants & Manufacturers
United Rubber, Cork, Linoleum, and Plastic Workers of America
United Shellfish Co. Inc.
United States Filter Corp.
United States Government:
- Civil Aeronautics Board
- Civil Service Commission
- Department of Agriculture
- Department of Commerce
  - Bureau of Census
  - Domestic and International Business Administration
  - Maritime Administration
  - National Bureau of Standards

ANNEX I

- Department of Commerce (cont.)
  - National Oceanic and Atmospheric Administration
    - National Weather Service
  - Patent and Trademark Office
- Department of Defense
  - Department of the Army
    - Corps of Engineers
  - Department of the Navy
  - Department of the Air Force
  - Defense Logistics Agency
  - Defense Mapping Agency
- Department of Energy
- Department of Health, Education, and Welfare
  - Food and Drug Administration
  - Office of Consumer Affairs
  - Office of Education
- Department of Housing and Urban Development
- Department of the Interior
  - Bureau of Reclamation
  - Geological Survey
- Department of Justice
- Department of Labor
  - Bureau of Labor Statistics
  - Occupational Safety and Health Administration
- Department of State
- Department of Transportation
  - Federal Aviation Administration
  - Federal Highway Administration
  - Federal Railroad Administration
  - National Highway Traffic Safety Administration
  - Saint Lawrence Seaway Development Corp.
  - Urban Mass Transportation Administration
  - U.S. Coast Guard
- Department of the Treasury
  - Bureau of Alcohol, Tobacco and Firearms
- Environmental Protection Agency
- Federal Communications Commission
- Federal Maritime Commission
- Federal Trade Commission
- General Services Administration
  - Federal Supply Service
  - Public Buildings Service
- Government Printing Office
- Interstate Commerce Commission
- International Trade Commission
- National Aeronautics and Space Administration
- National Labor Relations Board
- National Science Foundation
- National Transportation Safety Board
- Nuclear Regulatory Commission

Office of the Special Representative for
  Trade Negotiations
Postal Service
Small Business Administration
Smithsonian Institution
Tennessee Valley Authority
Veterans Administration
Veterans Administration Hospital, Washington, D.C.
United States Steel Corporation
United Survey, Inc.
United Technologies Corp.
Universal Bandag Inc.
Universal Instruments Corp.
Universal Leaf Tobacco Co.
University of Cincinnati
University of Indiana
University of Minnesota
University of Missouri
University of Nevada
University State Bank (KS)
Upjohn Co.
Upper Canada Manufacturing Ltd.
Urethane Foam Contractors Association
U.S. Brewers Association, Inc.
U.S. Growers Cold Storage
U.S. Gypsum Co.
U.S. Industries, Inc.
U.S. Metric Association
U.S. Oil Company
U.S. Olympic Committee
U.S. Tennis Court and Track Builders Association
Utility Equipment Co. International
Utz Potato Chip Co. Inc.
UV Industries, Inc.
Valley Lumber Corp.
Valve Manufacturers Association
Van Cleave Properties
Van Doren Red-E-Mix
Van Horn Co. Inc.
Van Pelt Brothers Dairy
Vans Store Equipment Co.
Varian Associates
Vaughn Construction Co. Inc.
VDO Instruments Corp.
Veeder-Root Company
Vera M. Riley
Verson Allsteel Press Co.
VF Corp.
Vierk Distributing Co.
Viking Inc.

Viking Industries Inc.
Village American Jeep, Inc.
Virgil C. Hamilton, Jr.
Virginia Polytechnical Institute Cooperative
Extension Service
Volk Tire Corp.
Volunteer Specialty Co.
Vulcan Materials Co.
Wabash Telephone Co-op
Wade & Sons Inc.
Waldo Brothers Co.
Walgreen's Liquor and Wines
Walker Brothers & Co.
Walker County Bank (GA)
Walker Pontiac Inc.
Wallace Murray Corp.
Wallace Packaging Corp.
Wallcovering Manufacturers Association
Wal Machine Inc.
Walnutport State Bank (PA)
Walter Jansen & Son
Walter Kidde & Co., Inc.
Walter Morris Investment Co.
W. A. Moyer & Sons Inc.
Ward Foods Inc.
Ware Manufacturing Co. Inc.
Warnaco Inc.
Warner Communications, Inc.
Warner Farms Inc.
Warner-Lambert Co.
Warren Hutty Ltd.
Warsaw Black Oxide Inc.
W. A. Scheurer
Washington Post Co.
Washington Star
Washington Woodworking
Watson Land-Cattle Co. Inc.
Waulkee Engineering Co. Inc.
Wayne Home Equipment Co.
Wayne Tire Company
W. C. Tingle Co. Inc.
W. C. Wiedenmann & Son, Inc.
WDVM TV (WTOP)
Weatherking Products Inc.
Weaver Potato Chip Co. Inc.
Webber Glass Manufacturers Corp.
Weber & Huston Inc.
W & E Chevrolet Sales
W. E. H. Rasmussen
Weil Oldsmobile Inc.

Weiss Shirt Co. Inc.
Welders Needs Inc.
Welding Research Council
Welding Service Co.
Wells Management Corp.
West Coast Lumber Inspection Bureau
West End Dairy
Westerman Print Co.
Western Builders Co. Inc.
Western Building Materials Association
Western Can Company
Western Concrete Reinforcing Steel Institute
Western Electric Co.
Western Extralite Co. Inc.
Western Forest Industries Association
Western Red Cedar Lumber Association
Western Red & Northern White Cedar Association
Western Reserve Bank (OH)
Western Timber Association
Western Wood Moulding & Millwork Producers
Western Wood Products Association
Westinghouse Electric Corp.
Westmoreland Coal
West Point - Pepperell, Inc.
Westvaco Corp.
West Valley Construction Co.
West Virginia Steel Corp.
Weyerhauser Co.
W. F. Wells & Sons Inc.
Wheelabrator-Frye Inc.
Wheeler E.E. Company
Wheeling-Pittsburg Steel Corp.
Whirlpool Corp.
White Consolidated Industries, Inc.
White Motor Corp.
Whittaker Corp.
Wight Nurseries Inc.
Wilburton State Bank (OK)
Wilhoit Gas Co. Inc.
William H. Rorer, Inc.
William Liquors
William L. Wallace & Sons
William R. Huey
William Wrigley, Jr. Co.
Williamette Industries Inc.
Williams Companies
Williams Furniture Co. Inc.
Willis Bank of Texas
Wilson Court Inc.
Wilson Manufacturing Co. Inc.

Windmill Nurseries Inc.
Wine and Spirits Wholesalers of America
Wine Institute
Winfred M. Berg Inc.
Winnsboro Plywood Co. Inc.
Winslow Paints
Winthrop-Atkins Co. Inc.
Wire Reinforcement Institute
Wisconsin Can Co.
Witco Chemical Corp.
WJAL TV (WMAL)
W. L. Meekins, Inc.
W & L Sales Co. Inc.
W. L. Sharpe Contracting Co.
WMAL Radio Station
Wolfs Inc.
Wolpin Co.
Women Council of Realtors
Wood & Synthetic Flooring Institute
Woodcraft Industries Inc.
Woodcraft Kitchens Inc.
Woodland Paving Co. Inc.
Woodley Liquors
Woodward and Lothrup Co.
Woodward Co.
Woolrich Woolen Mills Inc.
Workman Electronic Products
W. R. & F. Builders
W. R. Grace & Co.
Wright Pontiac
W. & W. Construction Co.
Wyeth Laboratories
Xerox Corp.
Yankee Screw Products Co.
Youngstown Steel & Alloy Corp.
Zalk Steel & Supply Co.
Zelda Fastener Co. Inc.
Zellwood Fruit Distributors
Zenith Auto Screw Product
Zenith Radio Corp.
Zimmer Paper Products Inc.

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